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APHID RESISTANCE IN POTATOES[1 2]

JEAN BURNHAM ADAMS

Division of Entomology, Fredericton, N B

INTRODUCTION

During the past decade it has become very evident that an attempt must be made to control the aphids concerned in the transmission of potato virus diseases Effective aphid control by insecticides, even under the most suitable conditions, is a difficult problem in the field Because of the ability of the aphids to give birth to living young throughout the growing season, without the intervention of male forms, a very small number of survivors can readily re-infest a crop The result is that although an insecticidal control may be effective as an insect control, it may and usually does fail as a vector control, by leaving a nucleus from which the aphids can readily become re-established The studies here reported would suggest that resistance to aphids in potato varieties may

[1]Contribution No 2360, Division of Entomology, Science Service, Department of Agriculture Ottawa, Canada

2—Acknowledgments Sincere thanks are due Dr D J MacLeod, Officer-in-Charge, Laboratory of Plant Pathology, Fredericton, for guidance, criticism, and the facilities for the pursuit of these investigations, to the various members of the laboratory staff, for suggestions and assistance in plot work, especially to Mr Leo Dionne, also to Mr W W Targett, Division of Entomology, who aided materially in the work on the plots, to Dr G W Simpson of the Maine State Experiment Station, and to Mr C L Hovey, previously of that institution, for advice and material, to Dr J L Sleesman, Ohio State Experiment Station, to Mr W M McCulloch, Nova Scotia, Mr S G Peppin, Prince Edward Island, and Mr H S MacLeod, British Columbia, of the Plant Protection Division, for materials, and to Dr F W Pirie, Grand Falls, N B, for sample potato varieties Wherever statistical information was necessary, it was generously supplied by Dr Geoffrey Beall, previously of the Dominion Entomological Laboratory, Chatham, Ontario

ultimately provide a means for the effective control of aphid-borne viruses in the field.

The Russian expedition which sent its explorers into the remotest parts of South America and Mexico, from 1925-1932, was searching for the home of the cultivated potato, and a selection of wild potato relatives, which might provide material useful to the effort being made to improve the type of potato in various districts in Russia. This expedition was soon followed by similar ones from Sweden, Britain, America and Finland, each of which collected a wealth of material to be used in the potato breeding programs already under way in the respective countries. Previous to this time potato improvement studies were concentrated on the production of varieties resistant to late blight (*Phytophthora infestans* DeBary), and of higher quality and greater yield than the varieties then in commercial use. The results of these expeditions added to already available material many *Solanum* species, which carried numerous qualities that have been included in the potato program of recent years. Some of these were frost resistance, light adaptation, tuber color and tuber formation. Little attention was given to insect resistance at this time, in spite of the fact that insects, aphids in particular, play such a critical part in the transmission of virus diseases of the potato (1).

Much time and money have been expended in the attempt to eliminate the aphid-borne viruses, *Solanum* virus 14 (of Smith) or leaf roll, and *Solanum* virus 3 (of Smith), a component of mild mosaic, by breeding for resistance to these viruses. Little attention, apparently, has been given to the possibility of breeding a commercially acceptable potato variety whose aphid resistance would be substantial enough to limit the spread, not only of these two viruses, but of all such aphid-borne viruses in the crop. Immunity to aphids is an ideal to be sought, but aphid resistance coupled with a degree of disease resistance, would undoubtedly minimize the field problem of disease control as it exists today. Aphid resistance alone would be a material aid to the industry. To quote Leach (10) "Insect resistance often escapes observation because the insect itself is not notably injurious, but it should be remembered that insect vectors of plant diseases may be very destructive indirectly through the diseases that they transmit. The inherent resistance of plants to insect vectors, therefore should not be overlooked in the study of plant diseases transmitted by insects." Very recently a few scientists have further emphasized the possibility of such inherent resistance to insects. In 1940, Kenneth M. Smith (20) made the following statement: "Since so many plant diseases depend upon

insects for their dissemination, any measures directed against the insect vector will help to prevent the spread of disease The production of resistant varieties of plants is a promising line of work and it is already giving fruitful results"

Review of Literature

The study of resistance to insects has been undertaken in a number of crops, and strawberries, raspberries, alfalfa, peas, apples, gooseberries and grapes, are good examples of the measure of success which has been achieved The classic example of insect resistance as a commercial influence is that of the resistance exhibited by the American grape to the grape phylloxerid, *Phylloxera vastatrix* Planchon Darrow, Waldo and Schuster (14) have reported upon twelve years of strawberry breeding and have shown that aphid-resistant strawberry varieties already exist and that such resistance is genetic The work on raspberries by Winter (23) and Schwartze and Huber (16), has been carried on in similar fashion with klendusic mosaic resistance in the cane, the desired result of the aphid resistance breeding Maltais (12) Dahms (3), Harrington (8), Searls (17), Painter (14), and others, have all reported upon the resistance to the pea aphid, *Illinoia* (*Macrosiphum*) *pisi* Kaltenbach, that is exhibted by certain clovers, and some pea and alfalfa varieties This resistance is so material that constructive attempts are producing varieties of both alfalfa and peas resistant to aphids As early as 1831, Lindley (11), reported that the Majetin variety of apple was resistant to attacks by the woolly apple aphid, *Eriosoma lanigera* Hausmann At this time the resistance was attributed to the hairiness of the apple leaves The Houghton variety of gooseberry has been shown to have strains which exhibit a material resistance to the gooseberry aphid, *Myzus houghtonensis* Troop (5) Some isolated reports that variation in reaction to aphid populations occurs in the potato, have been noted. One by Whitehead and Davies (22) indicates that Kerr's Pink was less susceptible to injury than some other varieties under conditions of light infestation Aphid injury as such has been discussed by Houser, Guyton, and Lowrie (9), in regard to *Macrosiphum solanifolii* Ashmead, the potato aphid, and by Young and Morris (24) on both Green Mountain and Bliss Triumph Cockerham (2) in an article in Annals of Applied Biology, makes the following statement, the first of its kind to be noted in the literature "A preliminary examination has also been made of the possibility that resistance to aphis-borne viruses may be determined through resistance to aphid attack The only observation of interest to record at present

is that although *Solanum polyadenium* appears to be exceedingly distasteful to aphids it has been infected with aphid-borne virus Y "

Recently Rieman and McFarlane (15) have shown that the resistance of the Sebago variety of potato to yellow dwarf may be linked with avoidance of its vector or vectors This explanation has also been suggested by Walker and Larson (21) in their discussion of the low incidence of yellow dwarf in the Russet Burbank variety The work most nearly comparable to that in course at Fredericton on inherent insect resistance is being carried on by J P Sleesman, and F J Stevenson at the Ohio State Experiment Station Drs Sleesman and Stevenson (19) are concentrating on the production of a potato variety resistant to the potato leafhopper, and are finding that hopper numbers are not always correlated with degree of injury The present experiment with aphids supports this fact also Previously Sleesman (18) had tested a number of wild potato species and some potato varieties He found that in the group tested, Irish Cobbler ranked high in susceptibility while certain species were more resistant Maughan (13) has also considered these reactions

Mlthod and Definitions

Such examination of potato varieties and species as are discussed in the following pages was undertaken under both greenhouse and field conditions To a limited extent greenhouse tests were conducted on cellophane-caged plants This method was soon discontinued due to the difficulty of controlling moisture within the cellophane bags The bulk of the greenhouse work was conducted on uncovered plants in the open benches, where aphid populations might develop at will, and where only the character of the plant influenced their movements In all such treatments each plant was infested with a similar number of adult aphids of the species *Myzus persicae* Sulzer Counts on the populations were made at weekly intervals and notes taken on the nature and degree of injury Greenhouse conditions during the period of each test, were kept as nearly standard as possible Temperatures ranged between 65 and 70 degrees Fahrenheit; relative humidity usually approached 75 per cent

Under field conditions it was necessary to use some method of confining aphid populations upon the test plants, and preventing contamination from outside sources To achieve this, the potato hills were protected by wooden frames covered with unbleached cotton These so-called "cotton cages" were built on wooden frames, covered with medium gauge (70 threads per inch) unbleached cotton, 30 inches by 30 inches

by 36 inches high The tops were provided with a bound slit (16 inches in length) for general observation of the enclosed plants, and sufficient slack was allowed so that the opening might be closed by gathering and tying with string The cotton cages were applied immediately after the seed pieces were planted, the bases were carefully built up with soil and a heavy spray of nicotine sulphate was applied to the inside walls of each cage through the opening in the top This was to exclude the possibility of aphid contamination prior to infestation This spray was repeated just before infestation, when it was necessary to remove the cages to thin the hills to a single stalk

Each test variety was infested in duplicate, the third cage served as a check on the health of the plants and furnished a standard of comparison for the variety throughout its period of test The three cages of each variety were planted from the trisection of two tubers, setts from the same tuber planting similar hills under each cage In all cases the test aphid was the green peach aphid, *Myzus persicae* Sulzer, the nuclei for the infestations were obtained from a non-viruliferous stock culture of aphids maintained in the greenhouse

As in the greenhouse, weekly examinations were made on the field material to determine the population of aphids and the degree of injury to the plants An index of the population was obtained by direct count up to a total of 200 aphids and by a 20 per cent sample of total foliage after that point The injury was divided into three categories, the two extremes were again subdivided as the occasion warranted The categories are "suceptible," "tolerant" and "resistant," "susceptible" having a subdivision of "very susceptible," and "resistant" a subdivision "very resistant," as the tests continued It is the hope that "immune" may some day follow "very resistant"

The plants that are classed as "susceptible" to aphid injury are those in which high or low population cause veinal blackening, rosetting at the terminal and axils, stunting of the plant, curling of the leaves, and finally leaf drop The "very susceptible" category is applied to the extreme cases of such injury in which winged dispersal aphid forms are common and abundantly produced Plants are classed as "tolerant" to aphid injury when they support high populations, give rise to relatively few winged dispersal forms, and show very little or no apparent injury as a result of the insects' feeding "Resistant" plants are those which are associated with the production of only very limited populations, or no aphids, and which show no physical injury when small populations do occur "Very resistant" plants approach immunity both as regards aphid populations and aphid injury

Experiments

In 1939 tests were being run in the greenhouse on several hundred potato seedlings to determine their resistance to leaf roll and mild mosaic The method of inoculation was by use of the vector, *Myzus persicae* Sulzer, each plant being infested with a given number of viruliferous aphids Late in the spring, many seedlings were severely injured by what appeared to be insect feeding The injury, however, in many cases, closely resembled that caused by *Solanum* virus 3 and *Solanum* virus 2, on susceptible varieties, and in these cases complicated the picture materially when readings were being made on the disease reactions of these plants A test using non-viruliferous aphids was made on several known commercial varieties to determine what was aphid injury alone, as well as on a number of representatively "injured" and "resistant" seedlings These preliminary tests were carried out in the greenhouse on cellophane-caged potted plants The results indicated that reaction to aphids was not clear-cut but gave a wide variation of symptoms from very severe injury to very slight injury depending on the variety of host material

An outdoor experiment was arranged for the summer months, in which the following varieties of potatoes were planted under large cotton cages out-of-doors Green Mountain, Warba, Irish Cobbler and Bliss Triumph These cages were not the standard 30 inches by 30 inches by 36 inches, previously described, but larger structures built for this experiment Three varieties were grouped clock-wise around a Green Mountain hill In all there were thirteen hills to a cage, twelve (3 varieties quadruplicated), around a single Green Mountain in the center Aphids of the species *Myzus persicae* Sulzer, reared on seedling turnips in the greenhouse were used to infest only the Green Mountain The experiment was conducted in this way in an attempt to determine the rate and direction of migration and a varietal preference if any existed The results were inconclusive Table 1 shows the distribution of the population after eight weeks

Table 1.—*Percentage distribution of aphid population on four potato varieties*

Warba	27 5 per cent of aphids
Green Mountain	26 0 " " "
Irish Cobbler	24 7 " " "
Bliss Triumph	21 8 " " "

The populations in all cases were low.

The following winter, 1939-'40, further tests were made in the greenhouse,—chiefly with seedlings As had occurred with this material the previous winter, some plants were actually killed as a result of aphid feeding The feeding was by high populations in some cases, and by low populations in others Some plants were tolerant to high populations, and although they supported a large number of aphids, little or no injury could be noted, still others were highly resistant to aphid injury and population build-up

In the summer of 1940, twelve potato varieties were chosen for tests and were planted, (June 26), in triplicate, under the cotton-covered cages out-of-doors On the 16th of July each variety was infested in duplicate with ten aphids per cage, the third cage served as a check on the health of the plants Just prior to infestation the cages were thinned to one-stalk hills Aphid establishment was not effected in most cases until the week of the 25th of July The varieties used and their classification as regards aphid injury appear in table 2

TABLE 2—*Relative resistance of potato varieties and strains to aphid attack*, 1940

Very Susceptible	Susceptible	Tolerant	Resistant
S No 41956	Chippewa	President	Warba
Katahdin	Irish Cobbler	Green Mountain	Up-to-Date
	Bliss Triumph		Epicure
			Houma
			Arran Victory

The peak populations ranged from 35,000 in Seedling No 41,956 and Katahdin to approximately 1900 as the peak in Arran Victory and Houma Katahdin and No 41,956 were dead six weeks after the establishment of aphid colonies Severe veinal blackening could be noted within ten days after the successful establishment of aphid populations Chippewa, Irish Cobbler and Bliss Triumph, were blackened and rosetted, but the symptoms did not appear until much later in the season Populations in relative abundance became established on President and Green Mountain, but no such injury as described for the previous varieties appeared at this time The varieties, Warba, Up-to-Date, Epicure, Houma and Arran Victory supported very limited populations and suffered no injury whatever The tolerance of Green Mountain suggests why so little dispersal occurred from it the previous

year The following years' data support this picture and suggest an explanation for the inconclusiveness of 1939 tests Some plants grown from tubers from the check cages were tested in the greenhouse during the winter of 1940-'41 Populations did not reach outdoor proportions but the classifications remained almost constant with the exception of the variety President, which moved from "tolerant" to a low bracket in "susceptible"

In 1941, fourteen varieties and strains were studied These included the varieties classified in table 3 Those selections marked "Simpson" were importations from Aroostook Farm, Presque Isle, Maine Material was planted on the 22nd of May in triplicate as previously, and infested with fifty aphids per each test cage on the 18th of June, after the cages had been thinned to one-stalk hills (Table 3) shows the classification of varieties under study in 1941

TABLE 3—*Relative resistance of 14 varieties and strains of potatoes to aphid attack*, 1941

Very Susceptible	Susceptible	Tolerant	Resistant
S No 41956 Katahdin Katahdin (Simpson)	Irish Cobbler Bliss Triumph Chippewa Sebago (Simpson) Pontiac (Simpson)	Warba Green Mountain President	Houma Up-to-date Earlaine (Simpson)

The populations ranged from a peak of about 60,000 in Katahdin to 14,000 as peak in Up-to-Date Again No 41,956 and Katahdin were dead in less than six weeks from the date of successful infestation

In the early spring of 1942 Blight Resistant Seedling No 996-1-4 produced by the Dominion Experimental Station at Fredericton, New Brunswick, was tested together with Green Mountain and Sequoia,—for its aphid resistance in the greenhouse The previous autumn the seedling had been selected in the field by a member of the horticultural staff of the Experimental Station, for its possible pollen fertility Examination of this plant at the time revealed very few aphids on its foliage although neighboring hills made up of other distinct seedlings, were in most cases severely infested The greenhouse test on the three varieties showed Green Mountain to be tolerant to relatively high populations, Sequoia proved resistant and supported only limited populations, the Seedling No 996-1-4 supported almost no population and showed no reaction whatever. In fact it was only with difficulty that

any aphids became established on this seedling The variety Sequoia has been noted for its leafhopper resistance under United States Department of Agriculture tests.

In the summer of 1942, Sequoia, No 996, *Solanum chacoense* and *Solanum polyadenium* were added to ten varieties previously tested under cotton-covered cages out-of-doors. The plot was planted on the 15th of June, and infested on the 20th of July, again after the hills had been thinned to one stalk each The classification for this year follows in table 4

TABLE 4—*Relative resistance of 20 varieties and strains of potatoes to aphid attack,* 1942

Very Susceptible	Susceptible	Tolerant	Resistant
Katahdin	Irish Cobbler	Waiba	Up-toDate
S No 41956	Sebago	Green Mountain	Epicure
Bliss Triumph	Chippewa	President	Houma
	Pontiac	Arran Victory	Earlaine
		Solanum Jamesii	Sequoia
			No 996
			Solanum chacoense
			Immune (under cages)
			Solanum polyadenium

As in previous years the very susceptible varieties Katahdin and S No 41,956 were in a dying condition within six weeks after successful infestation The immunity of *Solanum polyadenium* persisted throughout the season, but aphids were established on the stolons indoors during the winter. The apparent immunity of this species would seem to apply only to the area of green foliage Repeated attempts to infest this species under the outdoor cages, were completely unsuccessful Peak populations ranged from approximately 2,000 aphids on Katahdin and No 41,956, to no aphids on *Solanum polyadenium* The seedling No 996 never showed more than 38 aphids per cage at any time during the season, and those only one week after reinfestation with a second lot of 30 aphids.

In the winter of 1942-'43, in the greenhouse, preliminary tests for reaction to aphids were run on a part of the Empire Potato collection. A range of reaction was again noted It was particularly interesting to note that a test plant numbered E.P C. No. 10 and marked *Solanum tuberosum* was very slightly infested When it was subsequently iden-

tified it proved to be Up-to-Date, one of the varieties which had shown consistent resistance under cage tests out-of-doors

Early in the spring of 1943, aphid resistance studies were discussed with research workers at the Maine State Experiment Station. In the following summer months a program to study reaction to aphids in the potato was outlined at Aroostook Farm, Presque Isle, Maine. The writer had the privilege of following the current work on this project during the summer, and noted similarity in behavior of most varieties in Maine and New Brunswick during the season. The New Brunswick 1943 aphid tests were considerably enlarged as compared with previous years Upon the advice of Dr. Geoffrey Beall, from whom statistical information was solicited, the checks on the test material were doubled. Where previously only one check cage served two test cages, an additional check cage was added. In one 80-cage plot, 20 varieties and species were examined

These were planted on the 8th of June, under cotton cages The hills were thinned to a single stalk each and infested with 30 aphids per cage on the 10th of July The entire plot, checks and tests, was randomized this time Previously only the variety had been randomized and planting of the three cages was in one block Table 5 shows the 1943 range of reaction

TABLE 5—*Relative resistance of 20 varieties and strains of potatoes to aphid attack,* 1943

Very Susceptible	Susceptible	Tolerant	Resistant
S No 41956	Pontiac	Warba	Sequoia
Katahdin	Irish Cobbler	Green Mountain	*S chacoense*
Sebago	Bliss Triumph	President	*S commersonii*
	Chippewa	Arran Victory	Houma
			S demissum
			Epicure
	Very resistant		Immune (under cages)
	Up-to-Date		*S polyadenium*
	No 996		

The major dispositions of the varieties into categories remains very similar to that of the previous three years The injury suffered by the variety Sebago warranted its entry into the "very susceptible" category The variety Up-to-Date was materially resistant and showed only a low degree of infestation throughout the season The Frederic-

ton Seedling No 996 was almost free from aphids during the entire test period In spite of three infestations, peak populations, in either cage at no time exceeded the thirty original aphids of infestation The species *Solanum polyadenium*, the wild, vile smelling relative of the potato, was populated at no time during the summer It was infested on three separate occasions with 30, 30 and 100 adult aphids Finally a turnip top from the aphid stock chamber, very heavily infested with *Myzus persicae*, totalling several thousands, was introduced to one cage of *Solanum polyadenium* in an attempt to force aphids to feed upon this host The cage was examined forty-eight hours later Numerous aphids were crawling over the *polyadenium*, ground surface, and cage sides Three days later there were no living aphids noted in the cage

In addition to these 20 varieties, a preliminary test was also conducted to determine the aphid reactions of 70 additional potato varieties and seedlings Since the test was preliminary no classification is made here. The 1943 readings on these potatoes will be reflected in the table presented for the 1944 tests

In 1944, the field cage planting was randomized as previously and included eighty potato varieties and species These were planted on the 9th and 10th of July, under cotton cages, thinned on the 3rd of July, and infested on the 4th with 30 aphids per cage Checks and tests were randomized Table 6 shows the 1944 range of reaction

With so many varieties and species it has become increasingly difficult to make definite lines of demarcation between the classes The foregoing table is a result of careful study of the date of breakdown and the aphid population on each variety

As more varieties are tested, it will become necessary to use some mathematical index to compare their behaviors Study in this regard is now underway and the 1945 classifications will be presented in this manner at a future date

Discussion

An examination of the preceding tables will show that a number of varieties have occurred repeatedly in the same reaction bracket over five years of experiment, (table 7) The variety Katahdin, and the U S D A Seedling No 41,956, have in all cases been extremely susceptible to aphid injury and have supported peak populations of more than 30,000 aphids per two-hill cage In all cases the plants were so severely injured four weeks after infestation that the complete defoliation and usually death of the plant occurred, (Figures 1 and 2) It may be noted

TABLE 6.—*Relative resistance of 80 varieties and strains of potatoes to aphid attack, 1944.*

Very Susceptible	Susceptible	Tolerant	Resistant	Very Resistant
Great Scot	Flava	Triumf	Early Harvest	Up-to-Date
Katahdin	Red McClure	Early Rose	Shamrock (?)	*Solanum caldasii-glabrescens*
Colorado No 1608	Earlaine No 2	Ballydoon	Epicure	
Early Blue	Colorado No 891	Dakota Red	S. No. 996	
Netted Gem	Quick Lunch	Beauty of Hebron	Houma	
King Edward	Sir Walter Raleigh	Kerr's Pink	Northern Spy	
Garnet Chili	Majestic	Arran Victory	Sequoia	
Sebec	Pawnee	Red Warba	*Solanum chacoense*	
Parnassia	Earlaine	Pontiac (?)	*Solanum Commersonii*	
Early Epicure	Rural New Yorker	Peachblow	British Queen	
Hindenburg	Eigenheimer	Pawnee		Immune
Thorbecke	Snowflake	Deodara		*Solanum polyadenum*
West Bradbander	Kentville No. 116	Green Mountain		
	Arran Cairn			
	Golden	Susceptible (Cont'd)		
	Arran Scout	Pearl		
	Variety No 93	White Gold		
	Erie	Mohawk		
	Home Comfort	Arran Banner		
	Mesaba	Prolific		
	Russet Rural	*Solanum demissum*		
	Norkota	Idaho Russet		
	Albion	Big Rose		
	Jubel	White Rose		
	Rosafolia	Arran Consul		
	Blue Victor	Spaulding Rose		
	Brown Beauty			
	Prince Albert			
	Cowhorn			

(?) Indicates classification tentative

TABLE 7—*Varietal reactions of potatoes and some Solanum species to aphid injury*

Variety	1940	1941	1942	1943	1944
S No 41956	Very susceptible	Very susceptible	Very susceptible	Very Susceptible	—
Katahdin	Very susceptible	Very susceptible	Very susceptible	Very Susceptible	Very susceptible
Katahdin (Simpson)*	—	Very susceptible	—	—	—
Bliss Triumph	Susceptible	Susceptible	Very susceptible	Susceptible	—
Irish Cobbler	Susceptible	Susceptible	Susceptible	Susceptible	—
Sebago	—	Susceptible	Susceptible	Very susceptible	—
Pontiac	—	Susceptible	Susceptible	Susceptible	—
Green Mountain	Tolerant	Tolerant	Tolerant	Tolerant	Tolerant
President	Tolerant	Tolerant	Tolerant	Tolerant	—
Chippewa	Susceptible	Susceptible	Susceptible	Susceptible	—
Warba	Resistant	Tolerant	Tolerant	Tolerant	—
Arran Victory	Resistant	—	Tolerant	Tolerant	Tolerant
Solanum Jamesii	—	—	Tolerant	—	—
Up-to-Date	Resistant	Resistant	Resistant	Very resistant	Very resistant
Epicure	Resistant	—	Resistant	Resistant	Resistant
Houma	Resistant	Resistant	Resistant	Resistant	Resistant
Earlaine	—	Resistant	Resistant	—	Susceptible
Sequoia	—	—	Resistant	Resistant	Resistant
S No 996-1-4	—	—	Resistant	Very resistant	Resistant
Solanum chacoense	—	—	Resistant	Resistant	Resistant
Solanum Commersonii	—	—	—	Resistant	Resistant
Solanum demissum	—	—	—	Resistant	Susceptible
Solanum polyadenium	—	—	Immune (?)	Immune (?)	Immune (?)

*This strain of Katahdin was received from Dr G W Simpson, Maine State Experiment Station (Aroostook Farm), Presque Isle, Maine

1—Katahdin test plant, 1943, showing aphid injury, after four weeks' infestation

Katahdin, check plant, 1943, uninfested, same date

2—U S D A Sdlg No 41,956, 1943, test plant, after four weeks' infestation

No 41,956, 1943 check plant, uninfested, same date

here that the variety Katahdin has repeatedly sent out regeneration foliage after the insect population has become depleted as the result of the defoliation of the first crop of leaves The variety No 41,956 has not usually regenerated During the years in which Sebago, a late blight resistant release, has been tested, it has appeared to be susceptible to injury and during 1943 closely approached the behavior of Katahdin in its response

At the other extreme of reaction have appeared those varieties which have supported limited populations and have shown little or no injury Consistently these have been Houma, Up-to-Date, Epicure, and more recently a Fredericton blight-resistant seedling No 996-1-4, Sequoia, *Solanum chacoense*, *Solanum Commersonii* and *Solanum polyadenium*, the last mentioned species approaching immunity in its foliage reaction, (Figure 3).

3—*Solanum polyadenium* 1943, test plant, after four weeks' infestation *Solanum polyadenium*, 1943, check plant, uninfested, same date

Throughout the tests the commercial variety Houma has been resistant to aphid injury under cages Populations did become established but remained of limited numbers and little veinal blackening or leaf distortion occurred under New Brunswick conditions Up-to-Date was

uninjured in all tests and populations did not become abundant Earlaine has only been examined during two years, but exhibited a material resistance to population build-up and injury both times, (Figure 4) The Fredericton Seedling No 996-1-4, a second backcross

Fig 4—Fredericton Sdlg No 996-1-4, 1943, test plant, after four weeks' infestation

No 996-1-4, check plant, 1943, uninfested, same date

from a *Solanum demissum* Katahdin hybrid, [(*Solanum demissum* x Katahdin) x Katahdin] x Katahdin, has shown up extremely well in these tests The variety appears to be blight immune under New Brunswick conditions, and aphid populations, despite repeated infestation, have remained remarkably small This plant might serve as parental material in further breeding work in order to utilize its blight and aphid resistance if such should prove to be genetic The variety produces reasonably good size tubers with shallow eyes, and white flesh It is felt that tests on seedling progeny from this parent would be very valuable in determining a possible genetic background to this aphid resistance

The variety Sequoia, released by the United States Department of Agriculture and noted for its leafhopper resistance, has proved reason-

ably resistant to aphids also under the test conditions However, one case of severe injury in this variety has been noted in the field [3]

Solanum polyadenium exhibits the nearest approach to immunity to aphid injury noted to date, and, although infection with virus Y has been recorded by Cockerham, he does not state that it was by means of aphid transmission Solanum virus Y is also sap-transmissible

The resistance exhibited by *Solanum chacoense* and *Solanum Commersonii* is considerably less than that of *Solanum polyadenium* but more material than that of any of the commercial varieties with the possible exception of the three previously noted,—Houma, Epicure and Up-to-Date

Between these extremes of susceptibilty and resistance stands a substantial percentage of the commercial varieties examined Some of these have supported moderately large populations but have shown relatively little foliar injury These varieties have been classed as tolerant

The following pillar graph (Graph 1), has been prepared to illustrate the average of aggregate aphid counts on the following repeatedly tested varieties and species Green Mountain, Bliss Triumph, Katahdin, S No 41,956, Irish Cobbler, Up-to-Date, President, Chippewa, Warba, Arran Victory, Epicure, Houma, S No 996, Earlaine, Sebago, Pontiac, Sequoia, *Solanum polyadenium*, *Solanum chacoense*, *Solanum Jamesii*, *Solanum Commersonii*, *Solanum demissum*.

A complete list (table 8) in alphabetical order, of all potato varieties and species tested,—with their classifications,—is inserted here as a convenient check list for interested readers

From a purely pathological standpoint, there might be some breeding value in extremely aphid susceptible plants The value might possibly be related to what occurs in some rust-resistant wheats, where extreme susceptibles block off, because of the severity of injury to the cells, any attacking spores In this fashion an introduced virus might be blocked off because of the extreme aphid injury to the cells of the host potato This might explain why such a very aphid-susceptible variety as Katahdin remains so free from *Solanum* virus A in the field. However, it would seem wiser to utilize aphid-resistant species or varieties, in a breeding program whenever possible If such resistance be hereditary, not only insect resistance would be a result, but all aphid-borne viruses will be minimized as is the occurrence of their vectors

Let us consider what may cause aphid resistance in potatoes. Sev-

[3]The writer visited a small garden plot of this variety in Kentville, N S, on the 2nd of September, 1943 The entire plot was severely injured and populations were all *Myzus persicae* which were extremely abundant

GRAPH I.

PILLARS REPRESENTING THE AVERAGE OF AGGREGATE APHID COUNTS ON A NUMBER OF POTATOES OVER A PERIOD OF FOUR YEARS.

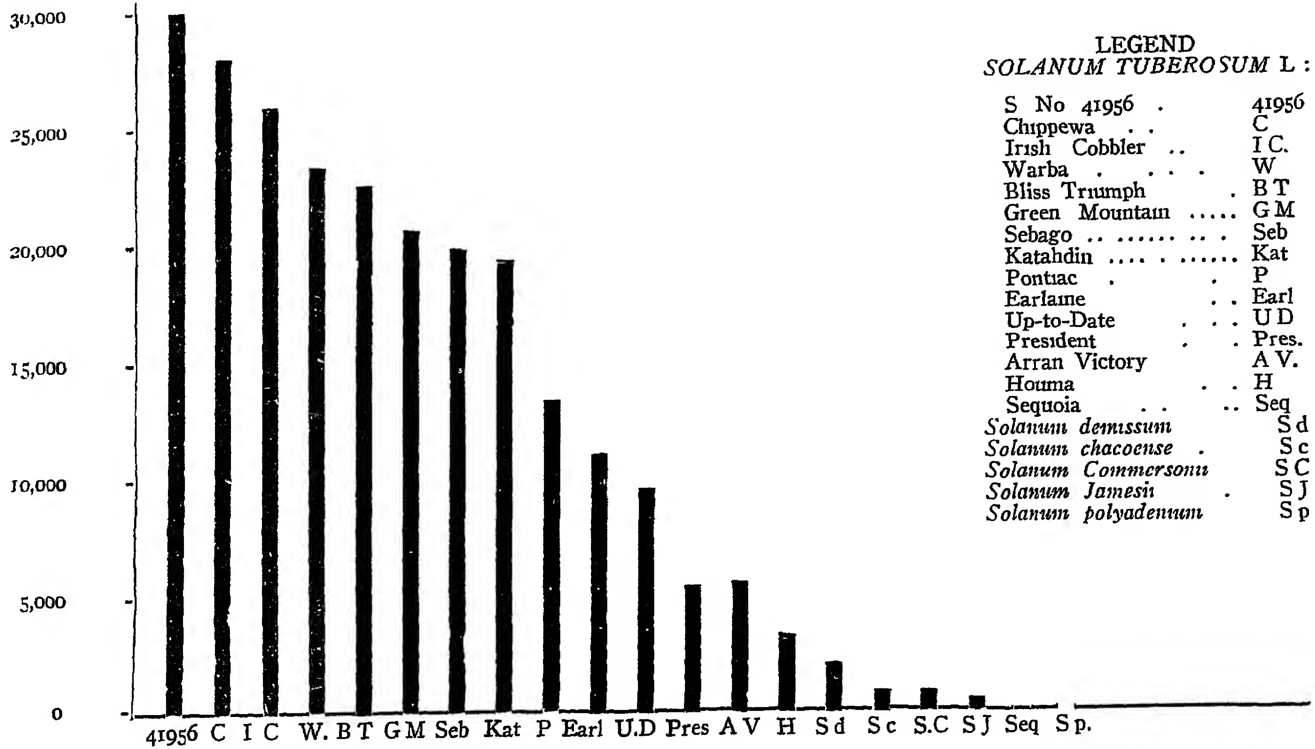

TABLE 8 *Relative resistance of 115 varieties and species of potatoes to aphid attack*

Very Susceptible	Susceptible	Tolerant	Resistant
Colorado 1608	Arran Cairn	Arran Victory	Alpha (?)
Early Blue	Arran Scout	Ballydoon	Ackersegen (?)
Early Epicure	Arran Banner	Beauty of Hebron	Brabander (?)
Garnet Chili	Arran Consul	Columbia Harvest	Blue Christie (?)
Hindenburg	Albion	Deodara	Bangor Rose (?)
Katahdin	Blue Victor	Early Rose	British Queen
King Edward	Brown Beauty	Early Ohio	De Soto
Netted Gem	Big Rose	Green Mountain	Early Pinkeye
Parnassia	Bliss Triumph	Magdalens	Epicure
Seedling No 41956	Burbank	Northern Spy	Early St George (?)
Sebec	Chippewa	Peachblow	Flourball (?)
Thorbecke	Colorado 891	President	Houma
West Brabander	Cowhorn	Red Warba	Irish Daisy
	Dakota Red	*S Jamesii*	Kentville 22 (?)
	Earlaine No 2	Triumf	LaSalle
	Earlaine	Warba	McKellar (?)
	Early Harvest		Noordeling (?)
	Eigenheimer	Susceptible (cont'd)	Ostragis (?)
	Ersteling		Ponting (?)
	Erie	Pearl	Simpson's Blue (?)
	Flava	Prolific	Sutton's Reliance (?)
	Great Scot	Quick Lunch	Shamrock (?)
	Golden	Red McClure	*S caldasii-glabrescens*
	Home Comfort	Rural New Yorker	*S neoantipoviczii*
	Idaho Russet	Russet Rural	*S ajuscoense*
	Irish Cobbler	Rosafolia	*S chacoense*
	Jubel	Seedling No 47102	*S commersonii*
	Kentville 116	Sequoia	*S acaule*
	Kerr's Pink	Sir Walter Raleigh	*S antipoviczii*
	Majestic	Snowflake	Seedling No 996
	Mesaba	*S demissum*	Up-to-Date
	Mohawk	Spaulding Rose	Immune
	Norkota	Sebago	*S polyadenium*
	Pawnee	Variety 93	
	Pontiac	White Gold	(?) Indicates classification tentative
	Prince Albert	White Rose	

eral workers have examined insect resistance in other crops, and a number of explanations why certain plants are resistant to attack, whereas others are susceptible, have been formulated Amongst these resistance factors have been placed morphologic characteristics repellent to colonization; physiologic conditions incompatible with the insects' development from the egg stage, in many cases, genetic resistance often intensified in the F1 generation The host resistance noted in regard to aphids in other crops has been variously categorized under many of these headings In the case of the potato, indications are that a truly biologic and genetic incompatibility exists Previously, hairiness in the host plant, has been the factor supposedly conducive to resistance But that this alone is not the explanation in the case of the potato, or more broadly the *Solanum* genus, is indicated by the fact that low populations and minimum injury have not been significantly correlated with hairiness in any particular group Particularly is this the case among the varieties of *tuberosum* In some instances relatively hairy-leaved varieties are susceptible to population build-up. In other cases so-called smooth varieties have completely escaped injury The Fredericton Seedling No 996-1-4 is a very smooth-leaved variety which suffers very little from aphid injury Certainly hairiness is not the protection offered here On the other hand Seedling No 41,956 is of more than average hairiness and yet is completely killed by aphids within six weeks These facts tend to minimize the role played by morphologic characters of this type in the aphid resistance exhibited by the potato

However, the resistance to aphids exhibited by *Solanum polyadenum* may be due in part to the presence of a repellent volatile oil which has been shown to exist on the foliage of this species Dr Sleesman (18) in his studies on leafhopper resistance, has shown that *Solanum polyadenum*, although normally repellent to leafhopper establishment, can be colonized if the foliage be washed with a strong soap solution This fact has also been demonstrated at this laboratory when it was possible to establish aphids, in limited numbers only, on *polyadenum* stolons, which appeared to be free from this oil Our experimental data do not indicate whether physiologic conditions be a predisposing factor in this regard or not The influence of condition of maturity on egg development would not be felt in the case of the potato aphids in this climate, since oviposition occurs only on the primary or woody winter host plants

It is interesting to note in this connection that a comparison of Sleesman's data with that of the writer indicates the possibility of a close similarity of reaction in the *Solanum* genus to both leafhopper and


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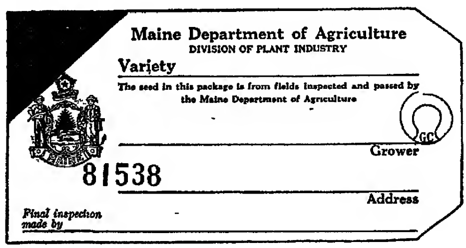

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aphid populations. Several species tested by Dr. Sleesman for hopper resistance have also been examined at the laboratory for their aphid reaction. In many cases a close relationship was found. In view of this fact it may be possible that resistance to leafhoppers and resistance to aphids are rather closely linked. If this be the case, any such leafhopper data would be useful in an aphid resistance breeding program.

Cockerham's reference (2) to *Solanum polyadenium* and his statement that it was infected with aphid-borne *Solanum* virus Y, has been noted. The avenue through which Cockerham's material may have become infected was not stated. In recent correspondence Dr. Cockerham expresses himself as still somewhat mystified by the method of infection.

The future work in this study will entail the careful testing of seedling populations and progeny from known parental groups, that the possibility or not of a genetic resistance be established. Should resistance to aphids prove to be genetic and resistance to aphids of potato varieties prove to be the dominant factor in field aphid control, future potato breeding experiments would from necessity incorporate the use of aphid resistant parents into their program. It is possible that such aphid resistance might be combined with other valuable characteristics such as those which produce quality, blight resistance, scab resistance, drought resistance, frost resistance, tuberization, response to light conditions influencing maturity, and finally true virus resistance.

Summary

The foregoing report on aphid resistance in potatoes considers the problem in the following manner.

1. Reference is made to previous studies on insect resistance in plants which have some bearing on aphid resistance in the *Solanum* genus.

2. The procedure and results of experiments carried on over the period of 1939-'45 to test aphid reactions critically in approximately 20 varieties of *Solanum tuberosum* and 5 other *Solanum* species, and generally in 90 other varieties, are described. The test aphids in all cases were of the species *Myzus persicae* Sulzer. Reactions have been classed as "very susceptible" (typically S. #41,956, Katahdin), "susceptible" (typically Bliss Triumph, Irish Cobbler, Sebago, Pontiac, Chippewa), "tolerant" (typically Green Mountain, President, Warba, Arran Vic-*Solanum chacoense*), and "very resistant" (Fredericton Sdlg. #996-1-4 Houma, Earlaine, Sequoia, *Solanum demissum*, *Solanum Commersonii*, *Solanum chacoense*), and "very resistant" (Fredericton Sdlg. #996-1-4 and *Solanum polyadenium*).

3. A discussion notes that potato varieties and species differ materially in their reactions to the feeding of aphid populations. Consideration is given to the possibilities of breeding potatoes resistant to aphid populations, both for the entomological and pathological value. A similarity between results obtained in leafhopper resistance studies and those found in aphid studies is noted

4 Tables, graphs and figures are utilized wherever possible for clarity

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HARVESTING AND SHIPPING EARLY POTATOES[1]

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INTRODUCTION

The present day consumer is becoming increasingly critical of the appearance and quality of the potatoes he buys. Not many years ago the crop was field-sacked, and the dirt-covered, partially sorted and poorly sized potatoes loaded into stock cars for movement to market. Today's housewife demands and will pay the price to get potatoes which are washed, carefully sorted and protected from deterioration during shipment Changed methods of preparing potatoes for market have brought new problems Washing has increased the difficulty of transporting the early and intermediate potato crops which are usually harvested and shipped during a season of high air temperatures, bright sunlight, low humidity and strong winds Generally the potatoes are immature when dug, and considerable skinning occurs thus exposing the tender tissues to these unfavorable conditions The resultant injury opens the way to rot-producing organisms, and moisture on the tubers during sacking, loading and shipping favors their development

The term "browning" has been applied to the injury resulting from exposure of skinned spots to damaging weather conditions. It is a discoloration of skinned areas which may occur to varied degrees, ranging from a light brown to a grayish black. In the case of tubers damaged only slightly, and in some instances with tubers injured somewhat severely, the browned areas heal under proper conditions so that rot does not develop, and the only detrimental effect is a slight injury to the appearance and some increase in peeling waste Skinned areas of the more severely injured tubers become brown or grayish black, are sunken and often covered with a sticky ooze after being held in storage for a few days or while en route to market Very severely browned tubers may break down completely, becoming moldy and decayed The term sunken "scald spot" is sometimes applied to the more

[1]The information in this paper is taken from Nebraska Bulletin 364, "Experiments on Shipping Washed Early Potatoes," by G B Ramsey, J. M Lutz, H O Werner and A D Edgar, Union Pacific bulletins "Handling Early Potatoes" and "Harvesting and Shipping Potatoes" Investigations were carried on by representatives of the United States Department of Agriculture, Nebraska College of Agriculture and Extension Service, Colorado Agricultural Experiment Station, Union Pacific Railroad and other individuals and firms with the cooperation of many growers and shippers

severe types of injury since it is descriptive of the appearance It should not be confused with "scald" which denotes localized spots or areas on the *unskinned* surface of tubers that have been injured by exposure to hot, bright sunlight, or to heat Bacterial soft rot is usually the most serious decay developing on areas injured as described above It is a sticky, soft or slimy type of rot which develops rapidly under warm, moist conditions The bacteria that cause this decay occur in all soils and, because of this fact, in the potato washer too; but they are unable to invade normal, healthy, undamaged tubers For this reason only tubers injured by scalding, severe browning, bruising, skinning or other means are subject to this decay Enlarged lenticels may also provide a path for entrance

Growers and shippers seldom realize the seriousness of surface browning The potatoes are hauled directly from fields to washing sheds and thence into refrigerator cars for shipment—usually being shipped the same day they are dug. Unless conditions during harvest have been extremely severe, browning and its harmful effect do not become evident in the comparatively short interval between digging and shipping Usually, only after the potatoes have reached the market does full development of the damage become evident Often the foul odor accompanying decay subsequent to browning is apparent when the car of potatoes is opened, whereas on the market damaged potatoes develop sunken areas detracting from their appearance, and quite often complete breakdown occurs rendering those potatoes unmarketable Carloads of potatoes in this condition are bought at a reduced price; the receiver must of necessity re-sort them—even then they are unattractive and have a low sale value The less severely damaged potatoes have a poor appearance even though decay has not developed

Methods of Investigation

Realizing the many problems encountered in handling early potatoes, the Union Pacific Railroad in 1940 initiated field and shipping studies to determine the best harvesting, loading and shipping methods The work was continued in 1941 while at the same time cooperating with other groups (see footnote page 24) in a two-year investigation to develop technical data The early studies were conducted in all early potato districts in Union Pacific territory, while the cooperative work was confined to central Nebraska and the early district at Gilcrest, Colorado In these sections most of the crop is harvested between early July and mid-September.

In the harvesting experiments, potatoes were skinned slightly as usually occurs in field harvesting, and samples were exposed on the ground or in sacks for varying periods of time. Appropriate instruments were used to measure temperature, humidity and other factors during the exposure period. Samples were kept in a cool cellar for five to six days following exposure to allow the effect of the damage to develop. Tubers were then counted into groups according to the intensity of the damage.

In the shipping tests, the quality of potatoes loaded and shipped under different conditions was compared by placing 100-pound test sacks obtained from one lot at the washing shed in one or more carloads of potatoes shipped to Chicago on the same day. The test sacks were placed in three critical positions as follows: one in the bottom layer at the bunker, one in the middle layer at the quarter-length position, and one in the top layer at the doorway. A thermograph placed in the center of each bag made a continuous record from the time the potatoes were loaded until they arrived in Chicago, and in some special tests, electric resistance thermometers were placed at twelve different locations in the load to permit reading the temperatures of the potatoes and air without opening the car. Upon arrival at Chicago, 100 tubers from each test bag were inspected to determine the percentage of blemishes and decay. The remaining tubers in each test bag were stored in a cool basement for one week after which another lot of 100 tubers was inspected from each bag. Only commercially significant blemishes and decay were scored in these inspections.

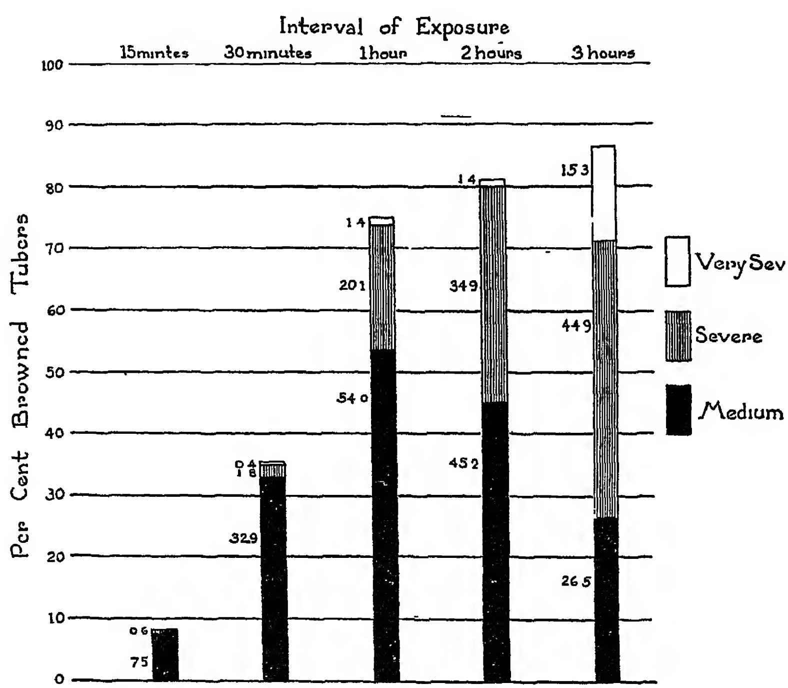
FIELD TEST RESULTS

The first year's shipping tests indicated that conditions and methods of handling prior to shipment were closely related to development of decay during transit. It was noted that damage done before loading could not be undone by any method of shipment. Therefore in 1942 and '43 the writer carried on an extensive investigation to determine the factors influencing browning and practical methods of preventing or reducing it. Considerable data were obtained, but for the sake of brevity only a summary of the results will be given here.

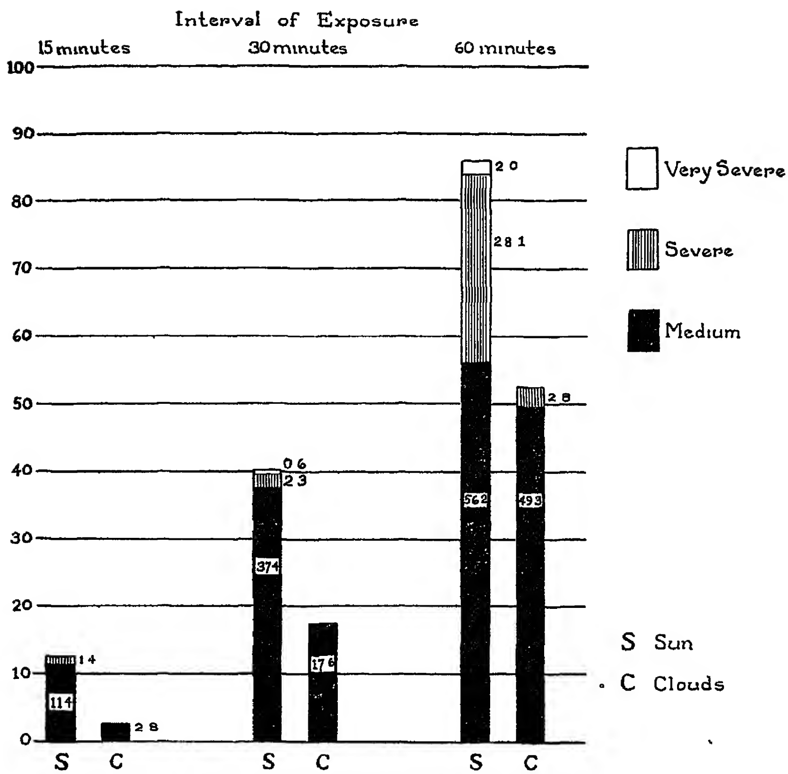
1. Air movement during periods when the evaporative capacity of the atmosphere is high, was found to be the most important cause of browning. Dry winds cause rapid loss of moisture from the skinned areas and discoloration results. If the injury is severe or conditions following browning are not favorable to wound healing, decay organisms enter and the tubers break down. The importance of drying winds was borne out by the occurrence of a great deal of browning on some days when the air temperature was low but when a drying wind was blowing.

2 Experiments with sacked potatoes substantiated the results obtained in tests in which unsacked tubers were exposed on the soil surface Tarpaulins over sacked tubers either standing on the ground when the wind was blowing, or on moving trucks reduced browning materially For example in one test representative of the results obtained in a number of others conducted under similar conditions, sacked, partially skinned potatoes exposed on the soil surface for one hour in the sun developed 96 6 per cent total browning, in the shade without protection from the wind, 84 3 per cent; and covered with a tarpaulin, 38 9 per cent. During the exposure period the wind velocity was 6 miles per hour, air temperature 97° F and relative humidity 35 per cent Use of canvas sacks during picking and hauling the potatoes to the washing sheds had the same beneficial effect as tarpaulins

3 Air and tuber temperatures alone were not reliable guides regarding the occurrence of browning Samples were exposed at various temperatures between 78° and 107° F, and there seemed to be no definite relationship between the temperature of the air and the severity of browning For example, during a test when the air temperature was 82° F., there was 80 per cent browning, whereas in another experiment during which the temperature of the air was 107° F. there was only 60 per cent browning



Average amount of browning in 40 samples of tubers exposed for various lengths of time.



Comparison of the average amount of browning in all samples exposed on sunny and cloudy days.

4 In these tests browning was not increased by greater light intensity, contrary to the common belief of potato growers that bright sunlight causes the damage In addition to measuring the light intensity during all tests, special tests were conducted to determine whether shade would reduce browning In a typical test, half of a sample of partially skinned potatoes was left on the ground whereas the other half was placed in the shade During the exposure period the wind velocity was 8 4 miles per hour and the relative humidity 37 per cent The potatoes in the sun developed 100 per cent medium and severe browning, while those in the shade had only slightly less, 92 3 per cent An average of all the tests showed that there was somewhat less browning on cloudy days, however, on those days the atmosphere contained more moisture than on sunny days and in most cases the wind movement was less

5 The length of time freshly dug potatoes are left on the ground before picking up, in burlap sacks before loading and on trucks en route and standing at the sheds, was found to be an important factor In tests with

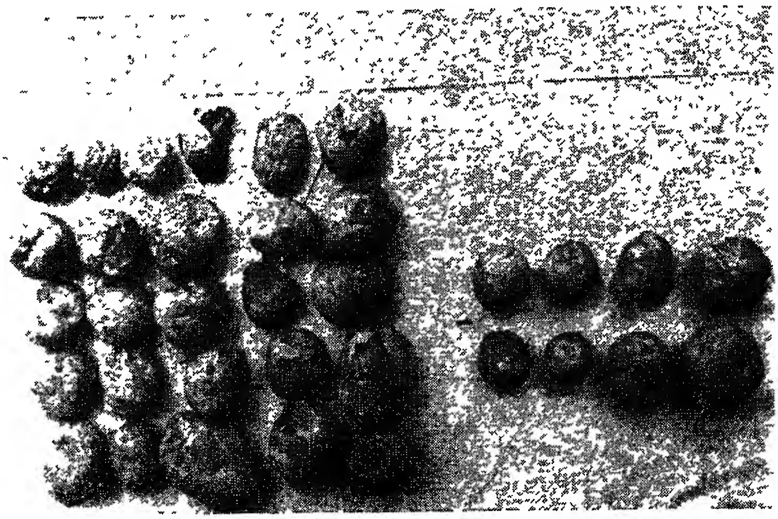


FIGURE 1 Potatoes exposed on moving truck for 15 minutes and at grading shed for 3 hours without tarpaulin Tubers on left badly damaged and those on right undamaged Samples were kept in cool cellar one week after exposure on the truck

partially skinned tubers exposed on the soil surface, serious browning seldom resulted from a 15-minute exposure, although at 30-minute exposure considerable browning occurred, and longer intervals resulted in serious browning and breakdown during the storage period

6. A significant finding was that scald or injury to unskinned potatoes or unskinned areas of partially skinned tubers was found in only one instance (sample of potatoes taken from a lot which had stood on truck overnight) in more than 3,000 tubers used in the tests Possibly scald might have taken place under more severe conditions, but the weather was favorable to scald injury during most of the tests During one test when the air temperature was 111° F, tuber temperature one-eighth inch under the skin, 141° F, sun bright, and a drying wind blowing at the rate of 4.4 miles per hour, there was no injury to unskinned potatoes, even in samples exposed on the soil surface for one hour

Shipping Test Results

Loading methods and types of loads were found to be of extreme importance in shipping immature potatoes Since quick cooling proved to be requisite, provision for circulation of cold air among the sacks was found to be essential The 5-3-2-1 (300 sack) and 5-3-2-3 (360 sack) loads provided these air channels while at the same time the load is tied in so that shifting during movement of the car was at a minimum However, even the best type load was no better than the proficiency of

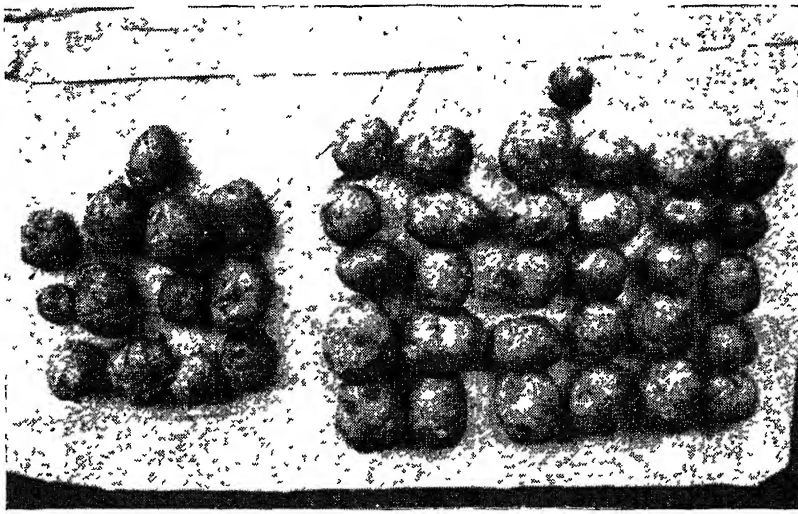


FIGURE 2 Same treatment as in picture above except that load was covered with tarpaulin Note much smaller number of damaged tubers in pile on left

the loaders Proper spacing of the sacks to provide air, and correct placement of the horizontal sacks to "tie-up" the upright sacks were found to be essential

The shipping tests conducted in Nebraska and Colorado showed that cooling early potatoes promptly after loading is an important factor in controlling decay development during transit When wet potatoes are loaded warm and remain warm for several hours, injuries of any kind may provide entrance for decay-producing organisms In general it was found that a transit temperature of 60° F was low enough for potatoes of good quality which had been handled carefully before and during loading Potatoes injured severely by heat or wind in the field or packing shed did not carry well even at temperatures as low as 50° F

The results of tests of various shipping methods are summarized below

1 *Standard Ventilation* (no cooling and hatch covers, hoods, and plugs closed after outside temperatures fall below 40° F, and opened when above) While this is the definition of standard ventilation, shippers may give special instructions to have ventilating devices opened or closed at certain points en route even though temperatures are higher than given above The experiments indicated that it is very hazardous to ship washed early potatoes under standard ventilation unless the maximum daily temperature at digging time is below 80° F Even then shipments without cooling at some point during the movement of the car, are likely to encounter

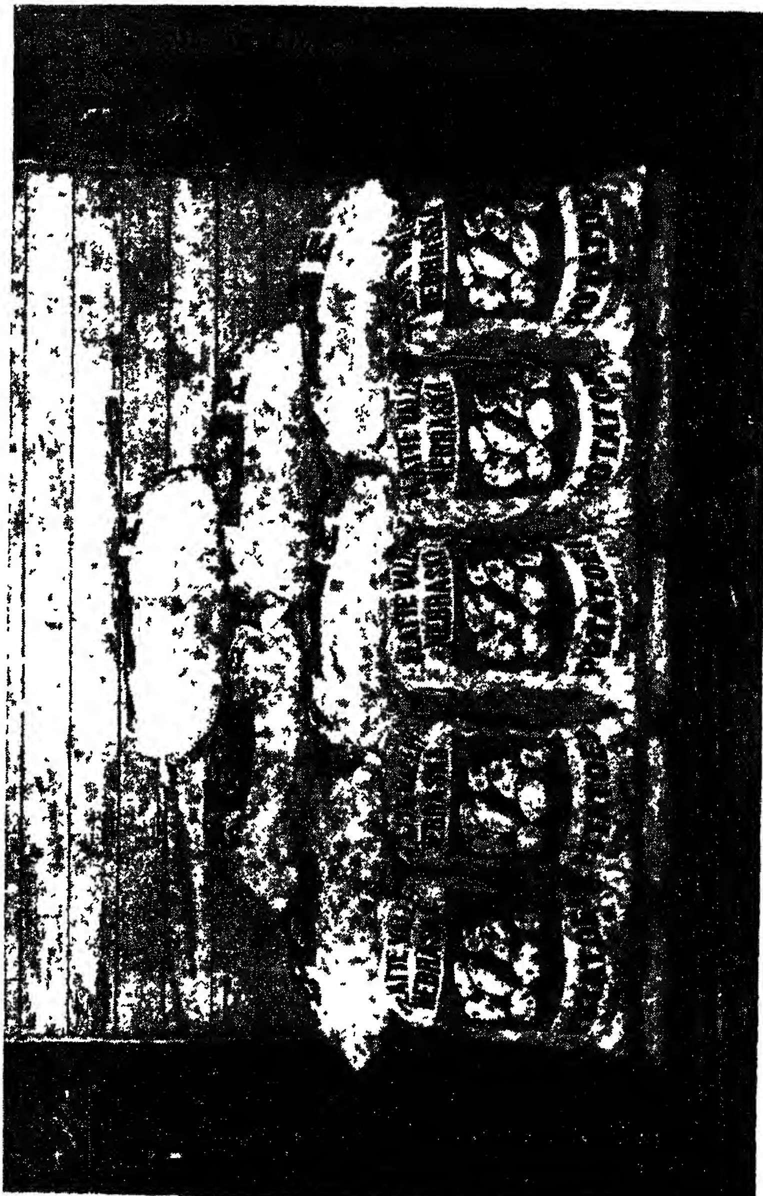


FIGURE 3 5-3-2-1 load designed to accommodate 300 one hundred-pound bags and

unfavorable conditions while en route Test bags in the cars moved under standard ventilation developed much more browning and scald spots during transit than cooled cars, and the potatoes usually presented a poorer appearance on account of excessive browning, scald spots, and withering

2 *Precooled* (artificial refrigeration machine mounted on a truck forced cool air into the cars for two to three hours, and cars were shipped with ventilating devices closed While providing the advantages of the opportunity for cooling immediately after loading and some drying from the movement of air through the car, this method was generally not so satisfactory as pre-icing The chief weakness was that the operation was seldom carried on long enough for thorough cooling The top layer of bags was cooled rapidly, but potatoes in the middle of the load were cooled so slowly that the precooling apparatus was often removed before the central part of the load reached a sufficiently low temperature Also within 12 to 24 hours the load often warms up to within a few degrees of temperatures in uncooled cars so that control of decay may not be satisfactory

3 *Delayed Icing* (cars initially iced after loading) Ice was not added until several hours after loading when the car arrived at the first icing station, and thus the effect of refrigeration was delayed Suitability of this method varied with conditions in the area in which the car originated In the Nebraska tests, where outside air temperatures were fairly high during loading and shipment, there was some decay, browning and scald spots in cars shipped under delayed icing, but the condition of the potatoes was much better than in standard ventilation cars Appearance was better than that of potatoes from precooled cars, but about the same amount of decay occurred The Colorado shipments being loaded under more moderate conditions than those from Nebraska (Colorado air temperatures were 65° to 70° F during these tests), moving 239 miles to the first icing station during fairly cool night temperatures and having a longer haul after icing, carried much better than did delayed iced cars from Nebraska There was very little decay and the average potato temperature upon arrival in Chicago was 50° F

4 *Pre-iced* (initially iced before loading—do not re-ice) Cars iced to capacity before being taken to loading points gave excellent results, reflecting the effect of immediate cooling Temperatures continued to drop as long as there was any ice in the bunkers, and decay was controlled effectively The potatoes had a bright, fresh appearance there was no withering, and generally no browning or decay The average temperature upon arrival in Chicago was 57° F

5 *Pre-iced and Re-iced* (standard refrigeration) Cars pre-iced as described above and then re-iced to capacity in transit furnished excellent refrigeration and arrived in Chicago with an average of 46° F, however, it appeared that with cars going no farther than Chicago, the cost of re-icing might well be saved Temperatures were lower than necessary and bunkers were from one-half to three-fourths full of ice on arrival

SECTIONAL NOTES

ALABAMA

At this writing the potato growers of South Alabama are undecided regarding the acreage they will plant With the commercial potato area located as it is near the shipyards of Mobile and the other ports of Pensacola and Gulfport, the availability and the cost of labor have been important factors in determining the acreage during the past 3 or 4 years This year there is considerable unemployment in the vicinity of Mobile, but workers are reluctant to seek other employment as long as they receive unemployment compensation The labor situation, therefore, is still a factor of importance in determining acreage in the Gulf Coast area of Alabama

According to present indications, approximately 19,000 acres will be planted in the Gulf Coast area This will be 1000 acres above last year's acreage The increase will come largely from growers returning from the service or from war jobs Indications are that 225 cars of the Triumph and 100 cars of the Sebago will be planted

Orders have been placed for seed and the certification authorities feel that the quality of the seed this year will be very good

It seems certain that more spraying and dusting will be done this years in an effort to reduce the loss from blight The acreages dusted will probably exceed the acreages sprayed (Jan 1)—L M WARE and FRANK GARRETT

CALIFORNIA

The Kern County potato growers began planting our early crop the first week in December and these plantings will probably be ready to market about the middle of April, 1946—Potatoes that were planted in August are now being harvested in this county The acreages of fall potatoes in the floor of the valley which are being harvested at this time, or will be dug within the next 60 days, consist of approximately 1600 The acreage to be planted for our spring harvest probably will not vary greatly from the acreage planted and harvested in 1945,—roughly 56,000 acres

The Federal potato goal for Kern County has not, as yet, been established. If a goal is established for Kern County on the same basis of the goal set for California, it would probably be slightly less than 39,000 acres as compared with the 56,000 acres grown in 1945 The present support price program as it has been announced will probably not influence the acreage greatly either way from the 56,000 acres

grown in 1945 It is too early, however, to determine what the growers are actually going to do (Dec 21)—M A LINDSAY.

INDIANA

This past week I had occasion to talk to several of the folks interested in potato production work and they showed very little or no concern over the potato support prices They did, however, show some concern in regard to the delivery of certified potatoes in Indiana The amount of seed that we get in will determine to a great extent the acreage that will be put out this year I presume that it will again vary between fifty and fifty-five thousand acres,—practically all of which will be consumed in Indiana

We have received letters from various parts of the country regarding items that have been in the Potato Journal, so evidently quite a few people read this publication Not long ago I received a letter from the Commonwealth of Australia, saying that they had read of certain work in the Potato Journal (Dec 18)—W B WARD

NEBRASKA

The principal topic of discussion by Nebraska potato growers is the car situation Three principal railroads serve the western Nebraska crop areas Not at any time have all our railroads had sufficient refrigerator cars to take care of our normal shipments One road may have enough on one day, and lack sufficient cars for the next several days Subsequently, another road may have some cars for one or two days, but there seems to be a shortage everywhere a greater part of the time

Most shippers are endeavoring to give preference to seed shipments, because of the pressure from southern states,—especially for certified potatoes Many shippers have stated that their table stock orders have been allowed to accumulate two or three weeks or longer. A number of the table stock markets have completely run out of potatoes, because of this condition.

The prices for table stock become higher because of the car situation Good prices, however, do not result in any benefit to the industry, because of the inability to deliver

Sales on certified potatoes have been good,—according to various shippers. Contracts for delivery during January and February represent a larger volume than usual The movement of these potatoes began during Christmas week, and will reach a peak about the middle of January Such shipments are going principally to Louisiana and Alabama, a good many more to Florida, Mississippi, and adjoining states

Texas shipments have practically been completed, and we are informed that planting is approximately completed in the lower Rio Grande Valley

Judging from the demand for seed locally, there will be a substantial acreage of potatoes next season There has not been much comment on the support program as announced for 1946. A great many of our growers have taken advantage of the program for 1945 Generally speaking, it has been very satisfactory (Dec 31)—MARX KOEHNKE.

NEW JERSEY

The New Jersey State Potato Association will hold its annual meeting in Moose Hall, Trenton, New Jersey, on the 24th of January. This is an all-day meeting starting at 10 00 A. M and will be held in connection with the annual Farmers' Week Program In the morning, a discussion of production and consumption trends, the government's potato goals, and the price support policy will be presented Potato grades and quality, with respect to market demands, will also be discussed as well as the results of potato spray experiments with DDT and other new spray materials The afternoon session will be devoted to an "Open Forum" on problems affecting the future of New Jersey's potato industry This discussion will be led by Dr Wm H Martin.

New Jersey potato growers are not particularly pleased with the announced price support program from the United States Department of Agriculture.

The Department has not made any announcement of prices for grades below U S No 1, but will announce prices on such grades if and when they are necessary

Base prices are on a bulk basis "loaded on truck at the farmer's gate" instead of at the f o b level as was formerly the case

New Jersey's basic support will be $1 50 per cwt, for July and August and increases to $1 80 in December Marketing services performed by the farmer will be added to these base prices However, this will bring the price of graded and bagged stock,—loaded on the car,—to not more than $1 93 in both July and August as compared with last year's prices of $2 20 for July and $2 25 for August

The potato goals committee recently received this price support program and gave a report vigorously protesting against these lower prices for 1946 The report stated that the announced prices will not guarantee the grower a price of "at least 90 per cent of parity" as guaranteed them under the Steagall Amendment and demanded a correction in the price support schedule in conformity with the law (Dec 5)—JOHN C. CAMPBELL

NEW YORK

The members of the Empire State Potato Club held their Annual Convention at Hotel Statler in Buffalo from the 3rd to the 5th of January The attendance was approximately 400,—the largest to date. Although the potato show was of excellent quality, it was not so large as in certain other years Edward L Kent, of Wellsville, Allegany County, won the sweepstakes award for the second year in succession His winning sample, consisting of 10 tubers, was a beautiful sample of Katahdin The trade show was also the largest in many years,—indicating a favorable outlook for business in 1946

After much discussion, the New York growers voted a resolution favoring the immediate elimination of all forms of government subsidies and production controls A feature of the informal meeting of potato growers held on the evening of the 2nd of January, was a canvass for information on the quantity of potatoes still in farmer's hands on the 1st Without exception, the upstate growers reported not more than one-half to two-thirds as many now as last year. The stock on hand on Long Island is apparently about the same or a little less than last year, despite the best crop ever experienced in the history of Long Island (Jan 9)—E V HARDENBURG

OREGON

Shortage of refrigerator cars is greatly hindering the shipment of both commercial and certified seed from the Klamath district Lack of cars is preventing many growers from seasonal marketing as they had planned. The situation does not look hopeful at the present time. Approximately 800 cars of seed are still unshipped and more than 4,000 cars, commercials, are still here, despite growers' anxiety to move them at the earliest possible date

Wording of the 1946 support program seems somewhat ambiguous to most of us The support price at the farmer's gate perhaps means the same as bulk in the cellar with a nominal allowance for grading, marketing and hauling to make it f o b cars The general opinion seems to be that a support price is very essential,—particularly in the face of further increases in agricultural costs, including labor. (Dec 27)—C A HENDERSON

LONG ISLAND

Only a very small part of the Long Island potato crop was placed in storage this past season and those that have been in storage are being moved as quickly as possible. For some reason that cannot be ex-

plained, they are not keeping as well as usual Because some of our larger growers could not market their crop as rapidly as they were forced to harvest it, explains why any potatoes were stored

The proposed reduction in the support price from $1 90 per cwt to $1 50 per cwt, at the farm, seems very unfair to our growers The shortage of farm help was greater during the past season than at any time Our regular labor is costing us upwards of eighty cents per hour In desperation, some of our farmers offered one dollar per hour this past Fall and even at that figure they were unable to get extra help At present we cannot see that the farm labor situation will be improved next season

I am opposed to the importation of farm labor The experience of our Long Island farmers has been that such labor is not only inexperienced but is very expensive

In view of the shortage of labor, the increased expense of growing the crop, and the greatly reduced support price, I believe that potato growers throughout the country should make a substantial reduction in acreage this coming season, and allow the shorter supplies to insure them of an adequate price (Dec. 18)—H R Talmage

POTATO MEETINGS
IN CONNECTION WITH THE INTERNATIONAL CROP IMPROVEMENT ASSOCIATION AT CHICAGO DECEMBER 3rd and 4th, 1945

In response to invitations issued by Bruce P. Jones, of the International Crop Improvement Association a fairly large group of people (over 75 signed the register) interested in potato production met at the Hotel Morrison during the morning of the 3rd of December. This meeting was attended by individuals representing many phases of the potato industry Those principally in attendance were seed certification officials, with a good sprinkling of growers and research workers from eastern states

The meeting was called to order by Bruce Jones Following preliminary discussion, it was decided to have an open forum type of meeting,—with individuals in charge of various discussions A general chairman was selected for each day Harry A Reilley of Michigan, was selected for Monday, the 3rd of December, and Bruce P Jones, New York, for Tuesday, the 4th Marx Koehnke was selected as Secretary and E L Newdick as Assistant Secretary Following is a list of subjects, together with the discussion leaders (Individual reports will be supplied by discussion leaders.)

Leafroll and Net Necrosis	Charles D Gaines, Washington
Late Blight	Reiner Bonde, Maine
Ring Rot	J W Scannell, Canada (District Inspector in Charge of Seed Potato Certification in Ontario, Canada
Scab Control	R J Haskell, United States Department of Agriculture
Foundation Seed Plot Work Including Winter Test Plots	H M. Darling, Wisconsin
Insect Control Problems	F. G Butcher, North Dakota
Storage Problems	Verne C Beverly, Maine (Co. Agricultural Agent, Presque Isle, Aroostook County, Maine)
New Varieties	E L Newdick, Maine
War Approved Seed and Ceiling Prices	**H. J. Evans, New York**
Certification Problems—Standards, Grades, Tags, Seals, Responsibilities, Etc	Marx Koehnke, Nebraska

ANNUAL MEETING OF POTATO ASSOCIATION OF AMERICA

St. Louis, Missouri, March 27-28-29, 1946

The American Association for the Advancement of Science and associated societies will meet in St Louis, Missouri, March 27 to 30, 1946 The Executive Committee has arranged for the Potato Association of America to meet with the A A A S.

Attention is called to the fact that hotel rooms are likely to be scarce; therefore, reservations should be made not later than March 17 All requests for reservations must be cleared through the Housing Bureau, A.A A S , 910 Syndicate Trust Building, St Louis 1, Missouri Requests must include definite date and hour of arrival, as well as definite date and the approximate hour of departure The names and addresses of all persons who will occupy the room *must* be included. Indicate your first, second and third choice of hotels when making your reservation

The St Louis hotels include the following American, Claridge, Coronado, De Soto, Gatesworth, Jefferson, Lennox, Majestic, Mark Twain, Mayfair, Melbourne, Roosevelt and Statler

Arrangement have been made to hold a joint session of the Potato Association with the American Society for Horticultural Science, Thursday morning, March 28, and a joint session with the American Phytopathological Society on Friday morning, March 29 Regular meetings of the Potato Association will be held on Wednesday afternoon, March 27, Thursday afternoon, March 28, and Friday afternoon. March 29

Titles of papers to be presented at these various sessions should be sent to W. H Martin, New Jersey Agricultural Experiment Station, New Brunswick, N J, as soon as possible.

ERRATA

In the November, 1945 issue in the article by A H. Eddins, entitled, "Transmission and Spread of Late Blight in Seed Potatoes," in the second line from the bottom on page 337, the following words should be inserted between "and" and "conducted" "The greatest spread in a bag containing 4 per cent diseased tubers Data from 2 tests"

American Potato Journal

PUBLISHED BY

THE POTATO ASSOCIATION OF AMERICA

NEW BRUNSWICK, N. J.

SOLAR HEAT IN RELATION TO BACTERIAL SOFT ROT OF EARLY IRISH POTATOES[1 2]

L. W. NIELSEN[3]

North Carolina Agricultural Experiment Station, Raleigh, N C.

Transit rots caused by various pathogens frequently cause great losses to shippers of early potatoes from eastern North Carolina In some cases the rot is traceable to field infection by *Pseudomonas solanacearum* or *Corticium rolfsii* In numerous other cases, bacterial soft rot,[4] is the dominant transit rot The severity of loss varies from year to year and, in some years, from week to week in the harvest season The reasons for these unpredictable losses have been perplexing to the growers as the potatoes have appeared to be perfectly sound except for bruising and skinning incurred by the harvesting and packaging operations

The harvest season in the early potato section usually starts the last week of May and ends the first week of July This is a season having relatively few cloudy days and temperatures approaching the maximum for the summer Some growers do not harvest during mid-

[1]Contribution from the Department of Botany, North Carolina Agricultural Experiment Station Published with the approval of the Director as Paper No 218 of the Journal series

[2]An abstract covering certain phases of the work presented in this paper was published in Phytopathology 33 1117, 1943

[3]Formerly, Assistant in Botany (Plant Pathology), North Carolina Agricultural Experiment Station, Raleigh, North Carolina

[4]Cultures of two pathogenic bacterial isolates were sent to Dr W H Burkholder. Cornell University, Ithaca, New York Although the isolates have not been identified at this time, he has informed the writer that they are neither *Erwinia carotovora* nor *Erwinia atroseptica*

day to avoid the intense sunlight, but many potatoes are exposed to the direct rays of the sun either while on the surface of the ground or while in picking sacks The effect of such exposure to direct sunlight in relation to subsequent soft rot development was the object of the following studies

Review of Literature

Recently Rose and Schomer (3) reported that freshly dug potatoes exposed to infra-red radiation developed temperatures of 140° F or more 1/16 inch below the exposed surface Potato tissue heated to these temperatures darkened and juice exuded from the lenticels This injury was observed in some tubers that reached 115° to 125° F Unsterilized tubers showing the symptoms of injury developed a foul smelling soft rot when held in a moist chamber at 90° F. for 24 hours They also state that potatoes heated to 115° to 125° F for an hour or more, readily develop infection when inoculated and held at 90° F (page 155) Ramsey *et al* (2) found that the sunny side of tubers had relatively high temperatures For several days the exposed sides of potatoes had an average maximum temperature of 111° F and an extreme of 135° F They observed that tubers heated to 125° to 135° F broke down and discolored Peacock *et al* (1) found that potatoes exposed to high solar and sky radiation for two or three hours may develop a rather high percentage of sunscald The sunscald injury was determined after storing the exposed potatoes for three days

Preliminary Observations

A number of experimental plots of Katahdin, Cobbler, and Bliss varieties of potatoes were harvested at the McCuller's Test Farm on the 11th of July, 1942. The potatoes were plowed to the ground surface at 10 00 A M[5] The atmosphere was clear following rains the previous night, the air was still and the sunlight intense The last plots were not picked up until 4 00 P M At this time tubers exposed to direct sunlight were very warm to the hand Many cases of sunscald were observed and about four bushels of the potatoes were placed in bags for further examination at a later date On the 16th and 17th of July these potatoes showed more than 50 per cent soft rot or showed symptoms of sunscald All varieties were affected

The symptoms of the scalded tubers were similar to those of potatoes observed in the field When cut open they had a sour smell The line of demarcation between injured and healthy tissue was indistinct,

[5]All time designations are Eastern War Time

but an exposure of several minutes to the air caused the injured tissues to turn brown Some scalded potatoes had not rotted, but the killed tissue had sunk, producing a cankerous-effect Lenticels in the region of the injury were dark, nearly black, and in some cases the eyes had turned a gray-brown color while surrounding tissue remained normal in appearance These latter symptoms were particularly noticeable for the white skinned varieties

Isolations were made from rotting potatoes of the three varieties Rapidly growing bacteria grew on all culture plates prepared from 25 tubers The colonies were white, and from 14 tubers, the colonies developed radiating outgrowths similar to strains of *E carotovora* The pathogenicity of these isolates was not determined

It has been observed on several occasions that potatoes dug in the late morning feel relatively warm to the hand Many tubers are formed very near the surface of the ground and possibly reach high temperatures on sunny days To test this possibility, temperature readings of the soil were made at various depths and of tubers buried at the same levels Tuber temperatures were measured with "dough" thermometers[6] inserted ½ to ¾ inch into potatoes, soil temperatures were measured with standard mercury bulb thermometers The data are presented in table 1 Tuber temperatures are the average of two tubers at each depth and located several feet from the thermometers for taking soil temperatures

Table 1 *Temperature of tubers and soil at various soil depths on June* 17, 1943 *

Depth in Soil		Degrees Fahrenheit at						
		11 40 A M Clear	1.25 P M Clear	3 00 P M Clear	4 00 P M Clear	5 00 P M Cloudy -rain	6 15 P M Rain	7 15 P M Cloudy
1 inch	Soil	104	114	111	112	103	89	85 5
	Tuber	102	112	110	109	100	84	82 5
2 inches	Soil	94	101 5	103	104	100	90 5	88
	Tuber	93	102	104	104	99 5	88 1	83 5
3 inches	Soil	91 5	98 5	101	102	98 5	93 0	89 5
	Tuber	90 0	95	97 5	98 5	97 5	92	88

*Air temperature 94° F

[b]Bulb of thermometer pointed

Tubers near the surface reached relatively high temperatures, and stayed at these temperatures for several hours. The vines were dead and provided little shade which is typical of most potato fields near the end of the harvest season.

In many cases, loads of potatoes stand for several hours in direct sunlight before unloading at the packing sheds The temperatures of tubers on the sunny and shaded sides of four loads exposed to the sun for different intervals of time are recorded in table 2 The potatoes in bags on the tops of the loads reached relatively high temperatures but none of those examined showed any symptoms of scald

TABLE 2 *Temperatures of tubers in burlap bags on the exposed and shaded sides of loads*

Load Number	Standing Time	Average Tuber Temperature - - °F					
		Exposed Side of Load			Shaded Side of Load		
		Average	Maximum	Minimum	Average	Maximum	Minimum
1[1]	—[3]	100	106	92	84 5	85	84
2[1]	—	99 5	102	96	84 5	87	84
3[2]	1 hour	118	123	108	86 5	88 5	84 5
4[2]	20 minutes	110 5	118	104	84 5	88	82

[1]July 15, 1943, 1 30 P M, intermittent clouds, maximum air temperature, 91°F
[2]July 16, 1943, 2 00 to 3 00 P M, clear day, maximum air temperature, 90°F
[3]Actual time not known, but estimated to be 45 minutes

The temperature of potatoes left on the ground for several hours was also measured Several acres were dug in the evening of the 16th of July, 1943 At 2 00 P M the following day (clear) tuber temperatures were measured Those in direct sunlight had an average temperature of 119 5° F A tuber shaded by a clump of grass had a temperature of 84° F Watery beads of exudate were oozing from lenticels of potatoes in direct sunlight The shipper of this field of potatoes later reported that the entire crop was a total loss due to rot in transit.

From these preliminary observations it was evident that freshly-dug tubers exposed to direct sunlight developed high temperatures In some cases, these high temperatures were associated with scald injury and an oozing of juice from the lenticels In other cases, soft rot apparently followed the exposure to intense sunlight. To get additional data on these observations, a series of field and laboratory experiments were performed and are reported in the following sections

Experimental Work

Development of Soft Rot in Tubers Exposed to Sunlight for Various Periods

A test was made on the 21st of July, 1943, to determine the effect of exposing Irish Cobbler potatoes to direct sunlight for different lengths of time on the development of soft rot It was clear during the forenoon,—with a maximum air temperature of 97° F for the day. The potatoes were dug and exposed on the surface of the ground at 10 00 A M Eight "dough" thermometers were inserted in tubers dispersed at random along the rows At regular intervals until 3 15 P M tuber temperatures were recorded One bushel of potatoes was picked up immediately after digging, placed in a bag, and held in the shade At hourly intervals additional samples were gathered and placed in the shade. This was continued until 3 15 P M. when the last potatoes were picked up The potatoes sustained only the cutting, bruising, and skinning injuries of the harvesting operation They were not mechanically graded All samples were piled in a room at the existing air temperature After two weeks' storage they were carefully examined for soft rot The data are presented in table 3.

TABLE 3 *Average tuber temperature during exposure to direct sunlight July 21, 1943, and percentage of tuber rot in potatoes two weeks after exposure to direct sunlight*

Time of Day	Exposure Time in Minutes	Average Tuber Temperature*	Percentage Rot after 14 Days' Storage
10 05 A M	0	82 2	3 57
10 25 A M	20	92 0	—
11 10 A M	65	104 2	10 1
12·10 P M	125	112 5	28 0
1 15 P M	190	119 5	—
2 15 P M	250	118 8	74 5
3 15 P M	310	116 6	78 5

*Average of eight readings

After an exposure of 190 minutes (1 15 P M) the potatoes reached an average temperature of 119 5° F Later, scattered clouds intermittently shaded the potatoes and they slowly cooled for the remaining time of exposure None of the tubers showed visible symptoms of injury

The data indicate a relationship between exposure to sunlight and subsequent soft rot development. The small percentage of rot in the

potatoes picked up immediately after digging developed in wounds or at the stem end. This sample was at the bottom of the storage pile, and all potatoes in the sack were wet from the juices of the rotting samples above The sack containing the sample picked up at 3 15 P M, after 310 minutes exposure to the sun, was wet when examined, although it was on the top of the pile; and 78 5 per cent of the tubers were rotted

Heat Injury and Development of Soft Rot in Tubers Exposed to Artificial Light

Tests were conducted in October, 1943, with artificial light to find the answers to the following questions 1. Can the relationship between heat injury and soft rot observed in the field be demonstrated in the laboratory under artificial irradiation? 2 How warm do tuber surfaces become in contrast to underlying tissue? 3 What is the critical temperature at which tuber injury occurs? Irish Cobbler tubers harvested in July and stored in a non-refrigerated basement until October were used in the experiments The artificial light was supplied by an electric bulb[7] with an internal reflector The light intensity upon the exposed tubers was regulated by adjusting the distance between the bulb and the tuber surface The tubers were supported on the dry surface of potted soil Temperatures were measured with "dough" thermometers and copper-constantan thermocouples The "dough" thermometers were inserted one centimeter into the tubers on the irradiated side The center of the thermometer bulb was used for determining the one centimeter insertion

A method for determining tuber injury presented somewhat of a problem Various stains were tested as possible "indicators" of injured tissue It was assumed that there would be a different rate of absorption of the stains by the injured and non-injured tissue Preliminary tests revealed, however, that the stains were unsatisfactory Since cooked potato tissue is a good medium for culturing many bacteria, slices of heated tubers, after cooling, were inoculated with a suspension of soft rot bacteria The bacterial strain was isolated from potatoes naturally affected with bacterial soft rot The culture was pathogenic when inoculated potatoes were incubated at or above 90° F It was found that slices of heated potatoes supported rapid growth of the bacteria at room temperatures (about 75° F), while non-heated tissue remained healthy The growth of the bacteria seemed to be restricted to the tissues injured as shown in figure 1 As a result of these tests,

[7]General Electric Mazda Projector Spot Bulb, 150 watts, 120 volts

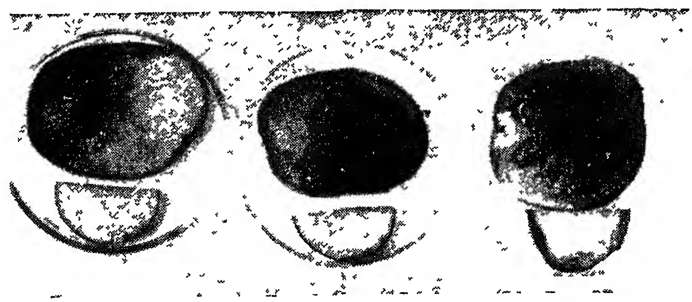


FIGURE 1. Bacterial infection of tubers previously irradiated with artificial light. Extent of bacterial infection apparently limited to tissues affected by heat. Half-slices are inoculated unheated controls.

this method was used to indicate tuber injury following various heat treatments. The inoculation was standardized as follows. A slice of tuber about ¼ inch thick was cut from the center of heated tubers. The slices were cut so as to pass through the center of the irradiated side. Aseptic precautions were not taken in cutting the slices of tuber. The slices were placed on two layers of moistened filter paper in a petri dish. A half-slice of non-heated tissue was also placed in the petri dish to serve as a control. The whole- and half-slices of tissue in each petri dish were inoculated with a suspension of soft-rot bacteria and incubated at room temperature for approximately 24 hours.

In the first series of experiments an effort was made to simulate the field conditions, that is, demonstrate the increased susceptibility of potatoes following a heat treatment. A few preliminary tests were made to determine the proper distance between the bulb and the tuber to give an increase in temperature comparable to that observed in the field. By placing the lower surface of the bulb 29 inches above the surface of the potatoes it was found that the rate of heat absorption was quite similar to that in the field. The following experiment will illustrate the results of these studies. Four tubers about 2½ inches in diameter were oriented in the cone of light so they absorbed heat at different rates. Temperatures were measured with thermometers inserted 1 cm. in the irradiated side of the tubers. Temperature readings were made at approximately 30- and 60-minute intervals for 295 minutes. Immediately following the heat treatment the tubers were placed in running tap water to dissipate the absorbed heat until the potatoes had again reached approximately room temperature. A slice was cut from each tuber and inoculated. A half-slice of non-heated tissue was similarly inoculated and placed in each petri dish. The results of the experiment are presented in table 4 and figure 2.

TABLE 4. *Rate of heat absorption by four artificially irradiated tubers*

Exposure Time	Temperature of Tubers in Field*	Artificially Irradiated			
		Tuber No. 1	Tuber No. 2	Tuber No. 3	Tuber No. 4
	°F	°F	°F	°F	°F
0	82.2	73.0	74.0	74.5	74.0
20	92.0	—	—	—	—
30	—†	93.5	95.5	99.5	99.0
55	—	101.0	104.0	108.0	109.5
65	104.2	—	—	—	—
115	—	111.0	113.0	118.0	122.0
125	112.5	—	—	—	—
180	—	115.0	118.0	121.5	126.5
190	119.5	—	—	—	—
235	—	118.0	120.0	124.5	128.0
250	118.8	—	—	—	—
295	—	120.0	123.0	126.0	130.5
310	116.6	—	—	—	—

*Same as those recorded in table 3.
†Temperature not recorded at this time interval.

Bacterial growth on the slices from the several heated tubers demonstrated that slow heating by artificial light made the tubers more susceptible to bacterial infection. Tuber No. 1 was heated more slowly than the potatoes in the field and reached a temperature of 120° F. Rapid bacterial growth occurred on roughly one-half of the slice indicating that the tuber had been injured to about one-half its thickness (Figure 2). Tuber No. 4 was heated most rapidly and reached a temperature of 130.5° F. This tuber was injured to its full thickness as evidenced by the bacterial infection. The other tubers were intermediate in rate of heating and extent of injury. None of the potatoes showed symptoms of lethal injury when sliced open for inoculation.

From the above experiment it is evident that the heat injury progresses from the irradiated side through the tuber. Heat penetration was further studied by means of thermocouples. A tuber about 2 inches at its smallest diameter and 3 inches at its largest was used. One thermocouple was placed inside the tuber 16 millimeters beneath the surface. A cylinder of tissue was removed with a cork borer to facilitate inserting the thermocouple. A second thermocouple was inserted under the epidermis (2 mm.) on the irradiated side. The tuber was irradiated for 195 minutes with temperature recordings every five or ten minutes. Following the heat treatment the tuber was cooled in tap

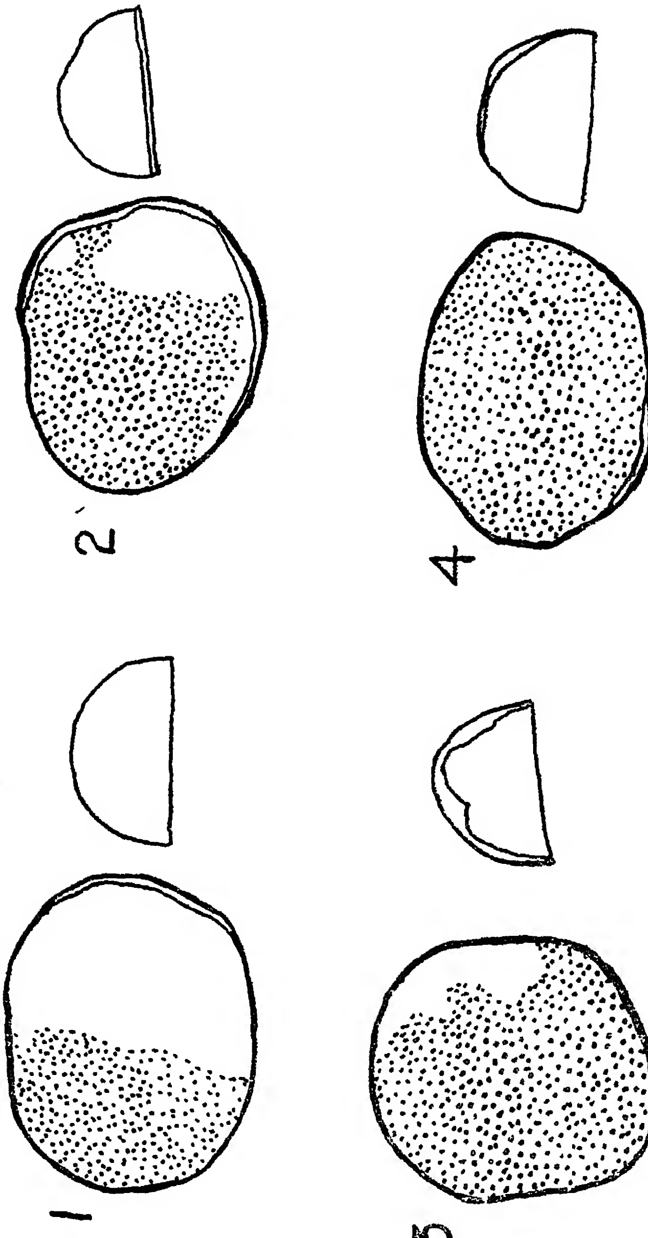


FIGURE 2. Extent of tuber injury shown by line drawings of inoculated slices from irradiated tubers (Table 4). Stippled area on slices indicates region of active bacterial growth. No bacterial growth occurred on the unheated half-slices. Line drawings copied from photograph.

TABLE 5 *Temperatures of a tuber at depths of 2 mm. (subsurface) and 16mm (internal) beneath the epidermis when exposed to artificial light for various periods.*

Exposure Time in Minutes	Subsurface Temperature	Internal (16mm) Temperature	Difference
	°F	°F	°F
0	76.0	76.0	0.0
5	89.8	77.4	12.4
10	92.1	79.2	12.9
15	95.1	80.8	14.3
20	99.4	83.1	16.3
25	103.8	85.2	18.6
30	106.5	87.5	19.0
35	108.2	89.8	18.4
45	111.8	94.5	17.3
55	113.7	97.5	16.2
65	115.0	100.3	14.7
75	117.0	103.0	14.0
85	119.1	105.5	13.6
95	120.5	107.5	13.0
105	121.7	109.1	12.6
115	123.0	111.0	12.0
125	124.0	112.7	11.3
135	125.4	114.3	11.1
165	126.9	117.1	9.8
195	129.5	120.5	9.0

water and a slice inoculated as described above. The subsurface and internal temperatures are presented in table 5.

The tissue near the surface warmed up very rapidly in comparison with the tissue 16 mm within the tuber The internal tissue reached a temperature of 120.5° F. The greatest temperature difference occurred 30 minutes after irradiation started At this time the sub-surface tissue was 19.0° warmer than the internal tissue. This difference slowly diminished and was only 9.0° at the termination of the experiment Bacterial infection of the inoculated slice extended to approximately 3/4 of the tuber thickness suggesting that temperatures considerably below 120.5° F can cause injury In a second experiment temperatures were measured 10 mm inside the tuber. The difference in subsurface and internal temperatures varied 13.5° to 7.5° F for a 135-minute exposure.

The time and temperature required to cause tuber injury were determined in a water bath with temperature controlled to two-tenths degree Fahrenheit Tubers 2 to 2½ inches in diameter were submerged in the water bath for 10, 30, and 60 minutes. The temperature of the bath varied from 139° to 106° F Following the heat treatment the

potatoes were cooled, sliced, and inoculated Non-heated control slices were similarly inoculated The combined data from three experiments are presented in table 6

TABLE 6 *The relationship of temperature and duration of heat treatment to tuber injury*

Exposure Time	Water Bath Temperature - - °F[1]									
	139	134 5	131	127 4	123 8	120 2	116 6	113	109 4	106
10 min	4/4[2]	3/3	3/3	3/6	3/6	0/4	0/4			
30 min		3/3	3/3	3/3	2/2	2/4	2/4	1/6	0/6	0/4
60 min				3/3	2/2	2/2	3/3	3/6	3/6	0/4

[1]Temperatures originally measured in centigrade
[2]In each fraction the denominator represents the number of tubers treated and inoculated while the numerator represents the number that became infected.

The temperature at which injury occurred was not sharp for the several periods of exposure The critical temperature for the 10-minute exposure was in the range of 123 8° to 127.4° F., 30-minute exposure, 113° to 116 6° F.; and the 60-minute exposure, 109 4° to 113° F. In these experiments the slice of tissue cut from each tuber was further cut in two One-half of the heated slice was inoculated while the other half remained uninoculated Those uninoculated half-slices previously heated to 120 2°, 116 6°, and 113° F. for 30 or 60 minutes remained healthy and showed no symptoms of injury after two or three days, while the inoculated slices became infected. This suggests that heat injury may be of two types, first, lethal injury; and, second, an "invisible" injury that alters tuber susceptibility

The above critical temperatures for injury of potatoes were further tested by exposing tubers to artificial light until the temperature reached 109 4° and 113° F In this experiment Irish Cobbler tubers produced in Maine were also tested These potatoes were the residual seed from the 1943 planting that were held at 38° F during the summer They were removed from cold storage and allowed to warm to room temperature Two Maine tubers and two North Carolina early crop tubers were exposed simultaneously "Dough" thermometers were used to measure temperatures When the temperature reached 109 4° F, one Maine and one North Carolina tuber were removed and cooled. After the remaining tubers reached 113° F they were removed and cooled Two slices were cut from the center of each tuber One slice was inoculated and the other not inoculated The results are illustrated by the line drawing in figure 3

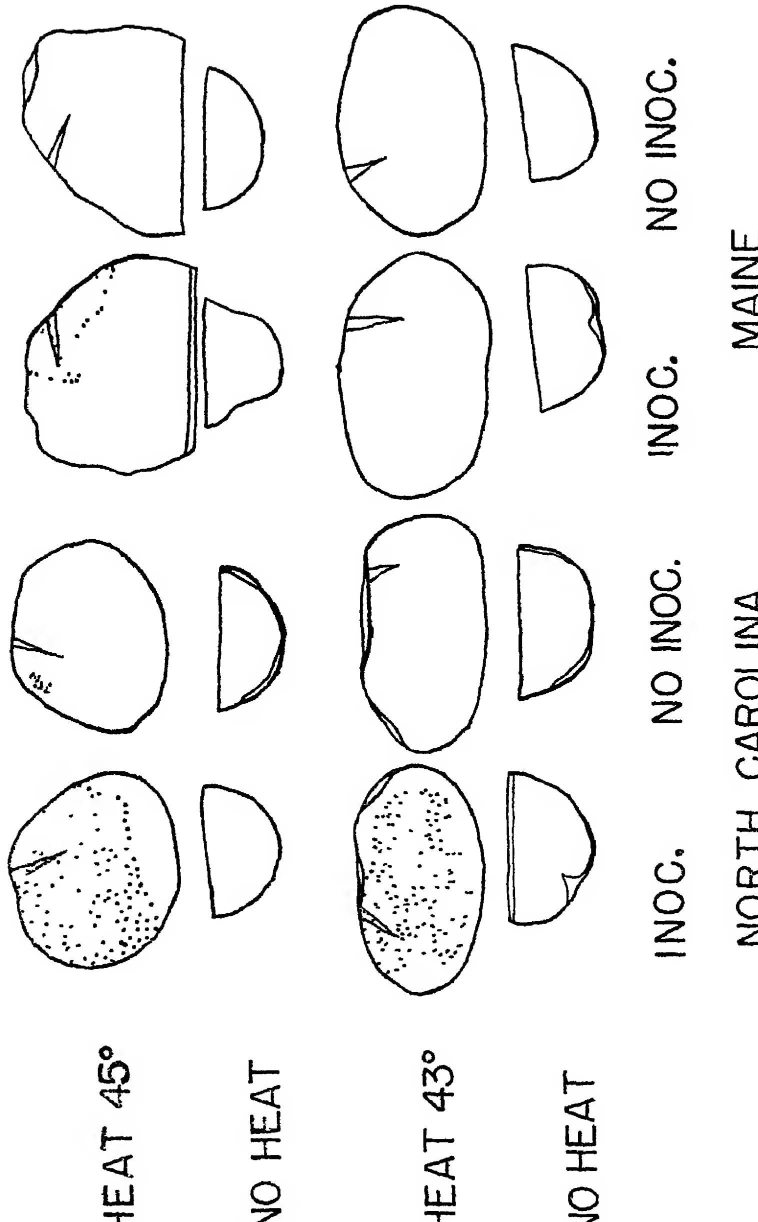


FIGURE 3 Injury of tubers from North Carolina early crop of 1943 and Maine seed crop of 1942 heated to 109.4° F (43° C) and 113° F (45° C) Stippled area on line drawings of whole slices indicates the extent of bacterial infection (heat injury) Wedge-shaped marks on whole slices represent point of inserting thermometer Line drawing copied from photographs

The older, cold storage Maine tubers did not respond to the heat treatment as did the North Carolina tubers. Infection developed on the slice of North Carolina tuber heated to 109.4° F., but not on the slice of Maine tuber. Infection developed on both tubers heated to 113° F. Injury was more extensive in the North Carolina tuber. These results indicate that the previous history of the potatoes alters the response to the heat treatment. They further show that tubers heated by irradiation to 109.4° to 113° F. are made more susceptible to bacterial infection.

The results (Figure 3) also illustrate the "invisible" type of injury. This is particularly so with the North Carolina tubers. Infection developed on both inoculated slices, but non-inoculated slices remained firm and showed no visible symptoms of injury except for a restricted infection on the slice from the tuber heated to 113° F. Since aseptic practices were not employed when cutting the slices, the local infection on this slice is understandable. The invisible type of injury was also evident on the uninoculated slice of the Maine tuber heated to 113° F. The repeated occurrence of this phenomenon suggests that sublethal temperatures induce physiological changes that modify tuber susceptibility to bacterial soft rot.

Effect of Wounding Tubers Exposed to Sunlight for Various Periods on the Development of Soft Rot

The field experiment conducted in 1944 was very similar to that conducted in 1943. One modification was made in an attempt to explain certain discrepancies between the 1943 data, 1942 sunscald observations and the laboratory data. On the basis of the laboratory data, a greater percentage of the tubers should have rotted in the 1943 field experiment as the average maximum temperature reached by the potatoes was 119.5° F. The coolest temperature making up this average was 114.5° F. All tubers were shaken from the vines and left on the soil surface to insure a direct exposure to sunlight. Notwithstanding these precautions for uniform heating of the tubers only 78.5 per cent of them rotted. The failure of the tubers that were severely sunscalded on the 11th of July, 1942, to rot is also a case of discrepancy. In many cases the cortical tissue had been killed as evidenced by sunken areas on tubers, yet these tubers were not rotting. The potatoes in these cases were picked, placed in bags, and stored. Tuber injury studies[8] have shown that many tubers so handled remain uninjured. These discrepancies in rot response after exposure to sunlight were assumed to be caused by non-inoculation of the heated tubers through bruises or skinned areas after the exposure. Provision was made in the

[8]Unpublished data.

1944 experiment to injure the potatoes after the exposure to sunlight. This was accomplished by running them over a mechanical grader as is done in all commercial operations. The grader injures nearly every tuber to some extent At the same time the tubers would probably be inoculated in the wounds by the contaminated grader.

The experiment[9] was conducted on the 20th of June on a commercial farm at Aurora, North Carolina Potatoes (Irish Cobbler) were dug at 8 00 A M and shaken from the vines to the surface of the soil Approximately one bushel was picked into a hamper immediately after digging and transferred to a burlap bag This sample was placed in shade from the direct rays of the sun Similar samples were picked at hour- to two-hour intervals throughout the day and removed to shade The last sample for the 20th of June was picked up at 7 00 P M All samples were run separately over the grading machine, placed in bags and transferred to an open machine shed The last sample was picked up at 7 00 A M on the 21st of June, similarly graded, and placed with the other samples The graded samples remained in the machine shed for one week before rot determinations were made

Tuber temperatures were recorded throughout the period of sun exposure Three temperature readings were taken at hour- or two-hour intervals The temperature readings presented in table 7 represent an average of the three readings made at each interval of time Temperature and rot data are also presented in table 7

TABLE 7 *Average temperature in degrees Fahrenheit of potatoes exposed to direct sunlight on the 20th of June, 1944, and percentage soft rot after storing the mechanically graded potatoes for one week*

Time of Day	Average Tuber Temperature	Percentage Rot after 7 Days' Storage
8 00 A M	82	0 0
9 00 A M	93	5 8
10 07 A M	105	15 5
11 07 A M	110	46 7
12 40 P M	116	97 3
2 00 P M	119	100 0
4 00 P M	116 6	100 0
5 00 P M	98	96 6
7 00 P M	96	100 0
7.00 A M*	77	63 3

*7 00 A M the following morning, June 21, 1944

[9]The writer is indebted to Mr. F A Todd for executing the experiment; and to Mr Max Thompson, Aurora, North Carolina, for supplying the potatoes and potato equipment for conducting the experiment

The potatoes reached a maximum temperature of 119° F at 2.00 P. M. An increasing number of scattered clouds progressively shaded the potatoes until 5.00 P. M., after which the sky was completely overcast. A cool wind started blowing at 4.00 P. M. and continued for the rest of the afternoon and evening. These meteorological changes account for the sudden drop in average temperature after 4.00 P. M. The maximum average temperature in the 1943 experiment was nearly the same (119.5°) as that for the present experiment. The maximum air temperature for the 20th of June, 1944, was about 90° F. The rate of heat absorption in 1943 was more rapid (195 minutes) than in the present test (360 minutes).

The data again show the marked relationship between exposure to sunlight and subsequent soft rot development. All tubers picked at 2.00 P. M. and later for the rest of the day became infected except that sample gathered at 5.00 P. M. This sample developed 96.6 per cent infection. Since the potatoes in this experiment reached approximately the same average maximum temperature as those in 1943, it appears that the greater percentage of rot was due to the inoculation through wounding by the grader. These data are in close agreement with laboratory data for tubers heated to this temperature.

The potato sample picked up at 7.00 A. M., on the 21st of June, is of interest. These potatoes had an average temperature of 77° F. and rotted to the extent of 63.3 per cent. These data are in agreement with those of Peacock *et al* (1, table 2), and suggest a recovery from the heat induced susceptibility. Peacock *et al* interpret this response as "probably due to the cooling off of the tubers which seems to check the injury and the toughening up of the outer tissues of the potatoes."

Discussion

The term sunscald does not adequately describe the effects of solar heat upon early potato tubers. The name implies a killing of tissue. This actually occurs in many cases, but for all potatoes heated to a lethal temperature there are possibly an equal number, if not more, heated to sublethal temperatures. Tubers heated to 113° F. for an hour or longer and then inoculated through bruising on a contaminated grader or artificially with soft rot bacteria will rot at temperatures lower than normally considered necessary for the development of bacterial soft rot. In the case of potatoes graded soon after an exposure to sunlight, the rotting at the lower temperatures may be caused by organisms other than *Erwinia carotovora*. Yet, the symptoms of many rotting potatoes so treated are those of bacterial soft rot. If potatoes heated to sublethal

temperatures are not wounded or artificially inoculated, they remain firm and from all external appearances, apparently normal Potatoes so treated have been held in the laboratory for several days to weeks without rotting, and with older tubers, they have sprouted. This suggests that the sublethal temperatures in some way temporarily alter the resistance of the tuber, making it more susceptible to bacterial infection This type of change or "injury" is not adequately described by the term sunscald

That the heat induced susceptibility is temporary is further suggested by work of Peacock *et al* (1, table 2), and the data presented in table 7 In both cases the amount of "sunscald" (1) and soft rot that developed in potatoes left on the ground overnight was less than that for similar potatoes picked up and handled the previous afternoon (day of sun exposure) This reduced infection has been interpreted as being caused by a toughening of the skin and outer tissues, but early potatoes left on the ground overnight have skinned as badly in the picking operation as similar potatoes dug and picked the previous evening (footnote 8) If the potatoes picked up the following morning were equally skinned and bruised in the harvesting operation, the failure to develop infection was due to some other factor Although temperature has been suggested, the data given in table 7 tend to minimize this factor Between 4 00 and 7 00 P M the average tuber temperature dropped 23° F, still the potatoes harvested at the later hour developed 100 per cent infection Since potatoes heated to sublethal temperatures failed to rot when held uninoculated in the laboratory for several days, and at the same time produced sprouts, it is suggested that the smaller percentage of "sunscald" and soft rot in the above cases was associated with reversible physiological changes in the tubers making them less susceptible to infection after remaining on the ground overnight

The results of the laboratory studies on temperatures and intervals of exposure were first interpreted as the thermal death point As the work progressed, it became evident that this was not correct The thermal death point of potato tissue for one hour exposure is probably above 122° F The temperatures determined in the laboratory experiments are more likely those at which changes in tuber susceptibility take place

Conclusions

Potatoes exposed to direct solar irradiation during June and July for as little as 60 minutes will develop more soft rot than potatoes picked up and packed immediately after digging Prolonged exposure may cause two changes in potatoes First, the potato tissue may be

killed, secondly, if the absorbed heat causes the temperature to rise to approximately 113° F or greater (sublethal), there will be no symptoms of injury, however, the tubers become more susceptible to the bacterial soft rot pathogen when inoculated through bruises caused by harvesting operations The latter change appears to be a reversible phenomenon from which tubers will recover if not inoculated naturally or artificially

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SPRAY MATERIALS AND THE BLOOMING OF POTATOES

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The physiological effects of spray materials on plant growth are mentioned frequently in the literature on disease and insect control (7). In the absence of disease, fungicides are more frequently injurious than beneficial Bordeaux mixture always has been one of those most likely to cause injury of one kind or another. Its use on young tomato plants often causes stunting, growth deformations and defoliation (8) Various other copper-containing compounds have similar, but usually less marked, effects On the other hand, Bordeaux mixture usually is credited with a stimulating effect on potatoes, although there is considerable evidence that it also may injure this crop (3)

The authors commonly have observed minor variations in the amount of bloom on potato plots sprayed with different materials during the past 10 or 12 years in Ohio (5), but the differences were never so marked as last year when DDT was used in some of the spray formulas Flower production on potato plants is regulated by a number of factors such as length of day, temperature, variety, rate of carbohydrate formation, etc The length of day is the most important single factor (2, 6) with maximum flower production when daylight persists for about 16 hours The relationship between the amount of bloom and tuber production is not entirely clear, but since flowering and tuber formation are concurrent processes, it seems likely one may affect

the other (1, 2, 6) Blooming of potatoes is encouraged by a rapid and heavy accumulation of carbohydrates in the tops under the influence of long, warm days, but an excess of bloom and fruit production may decrease tuber formation and later growth because of the element of competition for carbohydrates Spray materials may conceivably play a part in both processes by encouraging vegetative development and subsequent carbohydrate formation up to and including the blooming period, and then by influencing the retention of the leaf area necessary to develop the tubers The implications in such a combination of influences are both numerous and difficult to evaluate. Mader and Udey (4) reported that potatoes dusted with pyrethrum bloomed more profusely than those in adjacent plots that were untreated or that received Bordeaux mixture They ascribed this increase to a possible stimulation of the pyrethrum-treated plants

In 1945 an early (April 11) planting of Irish Cobbler potatoes at Wooster was sprayed with 50 different formulas, applied to small plots in four replications Various organic and copper-containing fungicides were used with calcium arsenate and with DDT, and DDT was used along in various concentrations and formulations, all at 20 gallons per acre The first spray applications were made during the first few days of June and by the end of the month the variations in the numbers of blossom clusters (cymes) beginning to appear on the differently treated plots was so great that the number of clusters was counted on each of the 200 or more plots The average number of blossom clusters per 100 plants that received various treatments are shown in the following tables, together with the average foliage score for the period between the 25th of July and the 11th of August, and the final yield of tubers in bushels per acre.

The data of table 1 show the average number of blossom clusters on each 100 plants in plots treated with various fungicides used in combination with calcium arsenate (4 pounds in each 100 gallons of spray material), the average (5 scorings) foliage score (percentage of foliage alive or in good condition for the period) between July 25 and August 2, and the total yield of tubers at harvest The first four materials listed are organic fungicides and the next four contain copper as the fungicidal agent Most of the organic materials increased the number of blossom clusters over those on the untreated check plants but all the copper fungicides caused a decrease. When the averages for each group of four materials are considered, it is evident that the decrease caused by the use of copper was much more marked than the increase due to the application of the carbamates. It is interesting

Table 1. Comparative number of blossom clusters on potato plots treated with various fungicides plus calcium arsenate as an insecticide

Fungicide + Calcium Arsenate	Number of Blossom Clusters per 100 Plants July 2	July 9	Average Foliage Score (per cent alive) for Period between July 25 and August 11	Yield in Bushels per Acre
Carbamate mixture	155	55	63	387
Zerlate	152	40	64	381
Fermate	135	45	56	331
Karbam (Methasan)	117	41	58	352
Oxychloride mixture	91	14	49	325
Tribasic	88	19	49	315
COC-S	85	22	58	333
Bordeaux mixture	67	15	59	336
No treatment	130	39	44	321
Average of four carbamates	140	45	60	363
Average of four copper-containing materials	83	18	54	327

that Bordeaux mixture caused the greatest reduction in bloom of any treatment used. This may be the result of some form of injury to the blossoms any time from the development of the flower primordia to fully opened blossom, or it may be connected with an even deeper physiological disturbance. One week after the first counts were made the blossoms had decreased by 70 per cent for the carbamates and about 80 per cent on copper-treated plots.

The differences in foliage condition and yield between the two groups of treatments are not so great as those for blossom clusters. This indicates that the relative influences of the various spray materials on bloom are not necessarily maintained at the same level throughout the growing season, and that disease control as it affects effective leaf area and concomitant tuber growth may be more important in determining final yields than what happens up to the time of bloom.

In table 2 many of the fungicidal materials listed in table 1 are shown in combination with DDT. The average number of blossom clusters per plant was increased when DDT was substituted for calcium arsenate, and the increase in bloom caused by the organic materials compared with that on copper-treated plots was not only maintained but became even greater. The injurious effect of Bordeaux on bloom was very definitely lessened by the addition of DDT and the number of blossoms on the plants treated with this combination exceeded that on the two fixed coppers + DDT. The bloom was also more persistent. The persistence of bloom was most marked on the

TABLE 2 *Comparative number of blossom clusters on potato plots treated with fungicides plus DDT as an insecticide.*

Fungicide + DDT	Number of Blossom Clusters per 100 Plants		Average Foliage Score (per cent alive) for Period between July 25 and August 11	Yield in Bushels per Acre
	July 2	July 9		
Zerlate	231	141	81	529
Sulfur	200	117	73	513
Dithane	198	94	71	450
Fermate	183	127	75	522
Bordeaux	120	60	79	523
COC-S	109	34	70	485
Tribasic	104	33	72	506
No treatment	130	39	44	321
Average of three carbamates	204	121	76	500
Average of three copper materials	111	42	74	505
Averages for Zerlate, Fermate, COC-S, Tribasic and Bordeaux—				
With Calcium arsenate	106	28	57	339
With DDT	150	79	75	513

Fermate and Zerlate plots whether they were used with calcium arsenate or DDT. Also, the bloom was more persistent with the carbamates than the coppers, and a much larger percentage persisted on DDT-treated plots than on those that received calcium arsenate

The average foliage condition for the two types of fungicides was approximately the same, and the yield of the plots that received copper plus DDT was even greater than that from the other group This further emphasizes the lack of correlation between bloom and yield in this part of this experiment

The average values for the five materials used with both calcium arsenate and DDT clearly show, not only the superiority of DDT with respect to foliage condition and yield, but also that its use results in a much heavier bloom on potatoes than does the use of calcium arsenate

The comparative number of blossom clusters do not tell the whole story in these data However, since the clusters were not only more numerous on DDT-treated plots compared with those that were treated with a copper plus calcium arsenate, but they were larger in all respects with more flowers per cluster For instance, there was an average of 3 2 flowers per cluster on the plants treated with Bordeaux mixture plus calcium arsenate, where the average number of flowers

per cluster on the plants treated with Zerlate plus DDT was 7.5. This means that there were 17.3 flowers per plant when they were treated with Zerlate plus DDT and only 2.1 per plant in the plots treated with Bordeaux plus calcium arsenate.

The data of table 3 indicate that the influence of DDT on blooming varies with the formulation. DDT used at 1/16 lb. in 100 gallons had

TABLE 3. *Influence of various DDT formulations used without a fungicide on the number of blossom clusters on potatoes*

Treatments (200 gallons per Acre)	Number of Blossom Clusters per 100 Plants		Average Foliage Score (per cent alive) for Period between July 25 and August 11	Yield in Bushels per Acre
Concentrations (Lbs. DDT per 100 gal.)	July 2	July 9		
1	162	148	50	532
¾	173	141	62	520
½	167	131	63	521
¼	163	117	59	517
⅛	159	104	57	517
1/16	120	67	53	466
None	130	30	14	321
Diluents				
Talc	194	131	60	537
Clay	187	114	60	509
Bentonite	184	120	62	513
Lime	176	122	58	499
Emulsions				
A	191	122	60	512
B	167	112	61	511
C	144	95	57	504
D	193	84	55	476

little influence on bloom even though it did improve the foliage condition and the yield to a certain extent. When the amount in 100 gallons was increased to ⅛ lb., the effect on bloom, foliage and yield approached the maximum obtained with higher amounts.

It is rather interesting to observe the influence of concentration of DDT on the persistence of bloom. Not only did the number of blooms increase as more and more DDT was added to the spray formulas (see table 3), but a larger and larger percentage lasted for a period of one week. The percentages of persistence were as follows: No treatment = 30, 1/16-100 = 52, 1/8-100 = 65, 1/4-100 = 71, 1/2-100 = 78, 3/4-100 = 81, and for the 1-100 formula, the value rose to 91 per cent, or almost a straight-line relationship.

When DDT was formulated with lime, not only was its effectiveness decreased slightly, but it failed to increase bloom as greatly as did bentonite, talc, or clay. When the DDT was applied as an oil emulsion there was an increase in bloom in most instances, but emulsion D which caused some injury to the foliage also decreased the bloom below that on untreated plants. The data of table 3 indicate some correlation between bloom and yield since blooming seems to decrease with yield when the formulation is weak in DDT or is somewhat injurious to the potato foliage.

The depressing influence of Bordeaux mixture on bloom is again illustrated in the first section of table 4 where the decrease is greatest

TABLE 4. *Influence of various factors on number of blossom clusters on potato plots treated with DDT*

Treatments	Number of Blossom Clusters per 100 Plants July 2	July 9	Average Foliage Score (per cent alive) for Period between July 25 and August 11	Yield in Bushels per Acre
DDT with different concentrations of Bordeaux				
4-4-100	129	80	68	[illegible]24
6-6-100	108	48	71	[illegible]40
8-8-100	88	40	70	[illegible]20
8-8-100 With calcium arsenate	67	15	50	336
No treatment	130	30	41	321
DDT spray (3-1-100)				
Every 10 days	201	110	70	484
Every 20 days	153	114	61	475
DDT Dust (3 per cent)				
75 lbs per acre	170	139	72	488
50 lbs per acre	202	133	72	489

with the strongest Bordeaux formula and least with a 4-4-100 mixture. This variation in bloom occurs independently of yield and foliage condition in the first three formulas listed in table 4. Bloom was also

more persistent with a 4-4-100 Bordeaux than when the formula was stronger, and for DDT than calcium arsenate

The use of DDT every 10 days caused a greater increase in bloom than applications made at 20-day intervals. When a dust containing 3 per cent of DDT was applied at 75 pounds per acre, blooming seemed to be retarded somewhat below that with a 50-pound application, but it was more persistent.

Materials such as Rothane and benzene hexachloride increased bloom to a considerable extent (168 and 160 clusters per 100 plants, respectively) The addition of zinc sulfate and lime to Tribasic increased the bloom to 131 for the combination, from 104 for Tribasic alonge The addition of LB72 to Dithane plus zinc sulfate and lime increased the bloom by 19 flower clusters per 100 plants

SUMMARY

Flower production by potatoes may be influenced by various factors Length of day is one of the most important of these Spray materials may also play a part through plant injury or by giving protection from insect and disease attack

Bordeaux mixture, which is known to cause various types of plant injury, caused the greatest decrease in bloom DDT increased the bloom more than any other material used in these experiments All copper-containing materials decreased bloom when used with calcium arsenate, but some of the organic fungicides like Zerlate and Fermate caused a slight increase

The addition of DDT to the copper fungicides decreased their depressing effect on bloom but did not entirely counteract it Combinations of DDT and the organic fungicides all increased bloom compared with that on untreated plants, and Zerlate plus DDT (2-¾-100) nearly doubled it

Bloom was least persistent in plants treated with copper plus calcium arsenate and lasted much longer with combinations of an organic fungicide and DDT Persistence was most marked where DDT only was used and was greatest with the heaviest concentration that was applied (1-100), at 200 gallons per acre

The amount of bloom increased with each increase in the amount of DDT used from ⅛ to 1½ pounds per acre for each application DDT emulsions increased bloom somewhat less than wettable powders There were fewer flower clusters on plants treated every 20 days than on those sprayed at 10-day intervals

There was little or no correlation between bloom and yield on plots

treated with combinations of fungicide and either calcium arsenate or DDT When DDT was used alone the plots that showed the heaviest flower production also produced the most tubers When copper-containing formulas are used, it seems likely that they depress bloom by some unfavorable physiological action, but they increase tuber production by giving the foliage continued protection from injury by diseases and insects after flowering has occurred DDT on the other hand encouraged heavy vegetative growth throughout the life of the plant and maintained a considerable leaf area on plants treated with it in these experiments until early blight finally killed the plants at the very end of their normal growth period, which persisted in this instance for at least 15 days beyond the usual 90 days for Cobblers at Wooster

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SECTIONAL NOTES

ALABAMA

Planting has started in the Bon Secour section of Baldwin County Unfavorable weather conditions have delayed planting in all sections of the county Planting will be pushed at all possible speed for the first two weeks of February,—weather permitting.

It is apparent at this time that approximately 17,000 acres will be planted in Baldwin County with an additional 3000 acres in the two adjoining counties of Mobile and Escambia.

The quality of seed has been unusually good, with the exception of some shipments that show damage caused by low temperatures.

It is estimated that the acreage of Sebago will run as high as 40 per cent Growers are taking the matter of late blight seriously. Early

planting, spraying, and dusting are being used as a means of reducing blight damage There will be more spraying and dusting than ever before in the section (Feb 2)—L. M WARE and FRANK GARRETT

INDIANA

So far, the potato growers in our state are *status quo* on the government's proposals of production and marketing We grow only a certain amount of potatoes and consume about double the production All of these problems were discussed at a recent meeting of 135 growers at Purdue

The Sequoia potato and its performance on the mineral soils aroused interest to such an extent that our muck growers are going to produce some certified seed for 1947 plantings. There is no doubt that several carloads of Sequoia seed could be disposed of at this time

Glen Shank, Fort Wayne, Indiana, was declared the state champ among the 400 Bushel Potato Club members, with 534 67 bushels No 1 grade He grew 22 acres of Sebago. This is the first time Sebago has headed the list in our state (Jan 29)—W B WARD

NEBRASKA

During the month of January, Nebraska potato growers were faced with the most serious car and shipping situation that they have had for a number of years The situation probably isn't must different than in other states However, a number of shippers carried their complaints to the Interstate Commerce Commission, in an effort to secure a greater allotment of cars to the Nebraska crop

With a crop of certified seed larger than the average, the Nebraska grower was faced with a very serious situation At the beginning of the shipping season, about the 1st of December, contracts on at least one-half of the certified crop were made As the shipping season progressed, and the car situation became tighter, it soon became apparent that much of the crop would not reach the market with the allotment of cars coming into the state

Many of the shippers of Nebraska Certified potatoes, who also ship table stock, simply ceased to ship table stock, and devoted all of the cars that could be secured to the movement of seed potatoes. As a result, most of the certified potatoes that were contracted were moved, though somewhat behind schedule During the same time, however, table stock growers found that they could not move their potatoes, and the prices advanced until the first of February

It is apparent that the planting of certified seed for 1946 will be on about a par with that of 1945 This is judged by the demand for Foundation Seed within the territory. The acreage planned for all potatoes in Nebraska is somewhat less than last year. The early table stock area, in Central and Eastern Nebraska, will be cut most sharply In the Western main crop section, the cut will be rather slight according to the present plans.

Not much can be said concerning the 1945 support program, since only a few sales have been made against loans that were granted in December. There has been some dissatisfaction on the part of growers because of misunderstandings on the part of local officials who have not been familiar with customary trade practices when the potatoes were graded and loaded It is hoped that a more definite and clear cut program will be in effect for another season. (Feb. 7)—MARX KOEHNKE.

NEW JERSEY

The annual meeting of the New Jersey State Potato Association was well attended and highly successful. Many of the problems of the potato industry were discussed A motion was adopted to assess the potato growers ½ cent for each 100 lb. potato sack which they purchase to raise funds for furthering the interests of the New Jersey potato industry. It was proposed to hire a full time executive secretary to work for the interests of the potato growers. The funds are to be used for promotional, advertising and research activities. This action on the part of the New Jersey potato growers is to be commended and should result in the improvement of the potato industry

Our growers' intentions to plant indicate a reduction in acreage varying from 5 to 10 per cent. Weather conditions this spring and the price of seed during the next two months will have considerable influence on the final acreage that is planted.

A car load of the Pawnee variety was brought into the state from Colorado and distributed to approximately 20 growers It is hoped that this new variety may prove to have a place as an early-maturing good quality potato for New Jersey The tubers have shallow eyes, a smooth skin and a generally good appearance

The Department of Agriculture's proposed consumer or retail standards for potatoes were explained and discussed at a recent meeting of the Northeastern Vegetable and Potato Council These grades, designated as A, B & C grades, closely parallel the present U S. No 1, U. S. Commercial and U. S No 2 grades with a reduction in the toler-

ance for defects to 5 per cent It is proposed to divide both the A and the B grade into seven gradations in size,—ranging from very small to very large. All the potato men at the meeting were opposed to the adoption of these grades and passed a motion to this effect. They considered the use of seven grade sizes very confusing and unnecessary

The Department is holding a public conference to discuss the adoption of these grades in Washington at the Department's South Building Auditorium, 14th St and Independence Ave, S W at 10 00 A M February 28th The potato industry should make its position known at this meeting (Feb 14)—JOHN C CAMPBELL

OREGON

Shipments of both seed and table stock are severely limited by car shortage The growers in this section seem to be generally opposed to Senate bill 1396 Growers are particularly opposed to quota attached to growers rather than the land If the quota would go with the land I believe Klamath County growers would favor this legislation There is a general feeling that support prices are necessary (Jan. 28)—C A. HENDERSON.

Certified seed is moving well Practically all of the White Rose has been sold at ceiling Our second most important variety, Netted Gems, or as it is called in some states, Russet Burbank, is starting to move at approximately ceiling price Table stock, although not bound by ceiling prices, is selling at about the old ceiling price for the best quality of Netted Gems, but is selling far below the old ceiling price for No 2's and miscellaneous off-grade stuff In other words, there is a very widespread difference between No 1's and lower grades.

Growers are not at all unanimous in their sentiments toward the Brewster bill in Congress Some want none of it, while others favor it There is a unanimous feeling among seed growers that if the bill should be passed, seed potatoes should be exempted from it They feel that because of various disease factors, the seed business cannot be stabilized and that no good grower, or no area producing better than normal certified seed, should be cramped by any type of quota or allotment

It is likely that with the high prices prevailing here for No 1's, growers in high yielding areas will plant about as much acreage in potatoes as last year Prisoners-of-war and Mexican labor were very helpful in getting in our crop last fall and growers are a little worried about the labor supply for digging if both classes of labor are unavail-

able The present trend toward concentration of acreage, in favored communities makes transient labor necessary for harvesting under our present conditions (Feb 6)—E R. JACKMAN.

SOUTH CAROLINA

Seed potatoes began to arrive in South Carolina two (2) or three (3) weeks ago. This is somewhat earlier than normal but the growers feel it is better to be early in these days of car shortage and uncertain train movement South Carolina's acreage was only 60 per cent of normal last year Early indications pointed toward increasing this to 70 per cent or 75 per cent of normal in 1946. If weather conditions do not radically change within the next ten (10) days, the acreage will be no greater than last year.

Katahdin and Pontiac continue to gain in popularity Last year plantings of Katahdin and Cobbler were about equal with 35 per cent to 40 per cent of the total acreage in each variety. Pontiac has gained rapidly and occupied about 15 per cent of the acreage last year. Sebago and Bliss, each, occupied approximately 5 per cent of the acreage Practically all of the commercial crop is planted with certified seed. State inspectors reported the seed in good condition on arrival A little late blight, rhizoctonia, and freeze damage have been found, but the amounts are insignificant.


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BACTERIAL SOFT ROT OF IRISH POTATOES AS INFLUENCED BY SUBLETHAL TEMPERATURES

SUGAR AND PERMEABILITY CHANGES IN THE TUBERS[1, 2]

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North Carolina Agricultural Experiment Station, Raleigh, N. C.

Recent studies indicate that potato tubers exposed to solar or artificial heat are made more susceptible to the bacterial soft rot pathogen. Heated tubers may show no visible symptoms of thermal injury, but when inoculated through bruises, cuts or artificially, they rot rapidly at temperatures varying from 75° to 80° F. This heat-induced susceptibility further appears to be a reversible phenomenon possibly associated with a reversible physiological process Sugar concentration of tuber tissue and cell membrane permeability of various plant tissues are known to be altered by changes in temperature The relationship of these physiological processes to the increased susceptibility of tubers heated to sublethal temperatures was the purpose of these investigations

MATERIALS AND METHODS

Potatoes of the Irish Cobbler variety were used for all experiments They were produced in Maine, 1943, and stored at Raleigh, North Caro-

[1]Contribution from the Department of Botany, North Carolina Agricultural Experiment Station Published with the approval of the Director as Paper No 219 of the Journal Series

[2]An abstract covering certain phases of the work presented in this paper was published in Phytopathology 34 1009, 1944

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lina, in an unheated room from October, 1943, until February and March, 1944, when the tests were performed. By February some potatoes had started sprouting and in extreme cases the sprouts varied from 1 to 1½ inches long The tubers for the experiments were prepared by storing samples in five constant temperature chambers for 10 to 20 days at temperatures ranging from 4° to 40° C. In addition to the effect of storage temperature some of the stored potatoes were given a sublethal heat treatment This treatment was for 60 minutes in a water bath at 47° C. Following the sublethal heat treatment the potatoes were transferred to a cold water bath to lower their temperature as rapidly as possible to existing room temperatures In all cases this sublethal treatment produced no visible injury

Sugar and hydrogen-ion analyses were made of the juice from stored and heated potatoes Three or more tubers having a total weight of 350 to 900 grams from each treatment were ground in a food grinder and the juice extracted by twisting the ground tissue in four thicknesses of cheese cloth All tubers showing external or internal symptoms of disease were discarded Immediately after extraction the pH of the juice was determined with a glass electrode Coleman pH Electrometer. The juice was filtered by suction to remove the starch, and cleared for sugar analyses by adding 5 c c of saturated neutral lead acetate to 30 c c of juice Following the removal of lead precipitate, the filtrate was added to 15 grams of potassium oxalate for removal of excess lead. The cleared juice was made up to 6 66 times its original volume Sugar determinations were made by the copper-iodometric method of Shaffer and Somogyi (10) and later adapted by Heinze and Murneek (5) for the determination of carbohydrates in plant tissue Duplicate sugar analyses were made of each juice sample

In all cases a slice of potato approximately one-fourth inch in thickness was cut from representative potatoes and inoculated with bacteria (7) to test the susceptibility of the variously heated potatoes In most experiments it was found expedient and satisfactory to cut a small piece about ¼ inch thick from either end of the tubers. These pieces were placed, cut surface down, on moistened filter paper in a petri dish The epidermis and about one millimeter of cortical tissue were cut from the upper surface of the piece of tuber exposing approximately ½ square inch A bacterial suspension was smeared over the cut surface, and the inoculated pieces were held for approximately 24 hours at 24 5° to 28° C. for infection to develop

Two bacterial isolates were used for all experiments Both isolates (#29 and #43) were cultured from diseased tubers during the

potato harvest of 1943. They have relatively high optima temperatures (Figure 1), and are rapid growers on neutral nutrient agar and in nutrient broth. Both produce radiating colonies when sown thinly in nutrient agar; and are pathogenic above 90° F. on slices of potato tubers. No attempt was made to determine, physiologically, the identity of the isolates. They were assumed to be thermophilic strains of *Erwinia carotovora*.[4] Rose and Schomer (9) mention a strain that may have been similar (page 155). Suspensions of two- to four-day-old cultures were used for all inoculations.

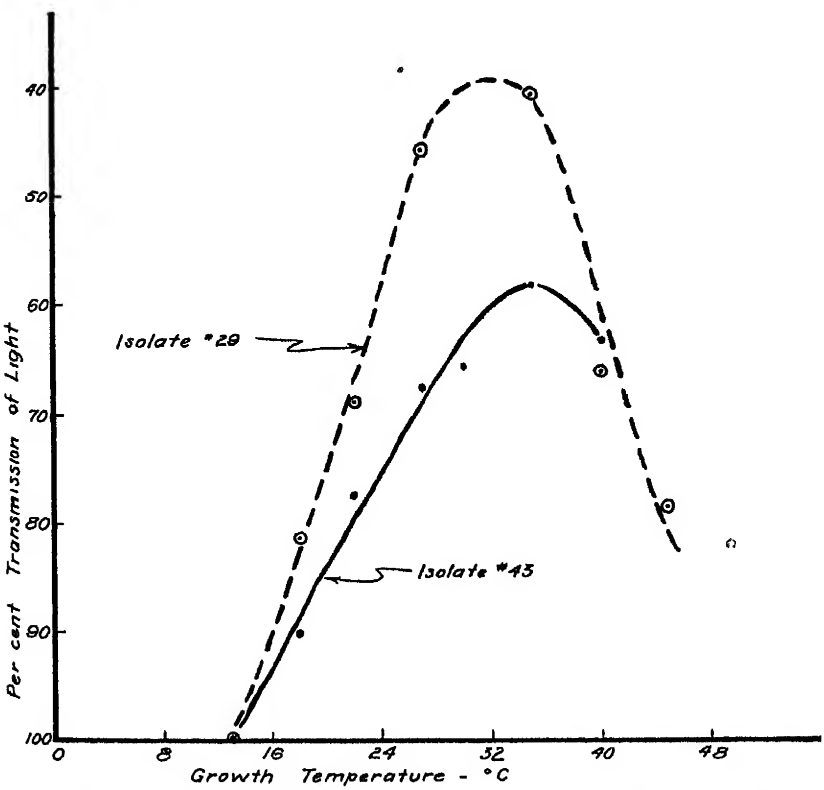

FIGURE 1. Growth curves for bacterial, soft rot isolates No. 29 and No. 43 in neutral nutrient broth at different temperatures. Growth period, 39 hours for isolate No. 29, and 24 hours for isolate No. 43. Determinations of growth made with Fisher Electrophotometer employing filter number 425.

It has been repeatedly demonstrated that the sugar content of

[4]Cultures of isolates No. 29 and No. 43 were sent to Dr. W. H. Burkholder, Cornell University, Ithaca, New York. Although the studies with the isolates have not been completed, he has informed the senior author that they are neither *Erwinia carotovora* nor *Erwinia atroseptica*.

potato tubers increases when stored at temperatures approaching 0° C., and that when removed to warmer temperatures (about 20° to 25° C.) for several days to weeks the sugars practically disappear (1, 13, 14, 3, 4). This reversible change in the sugar-starch equilibrium conditioned by altering the storage temperature suggested a possible mechanism for the increased susceptibility of potatoes exposed to sublethal temperatures. Temperatures from approximately 26° to 0° have been studied by the various investigators In the present studies the temperatures of interest are to the other extreme, *i. e*, 20° to approximately 48° C If the sugar-starch equilibrium is shifted to the sugar component at the higher temperatures, an explanation of the increased susceptibility might be available Therefore, a study of the change in the sugar-starch equilibrium at high temperatures was made

EXPERIMENTAL

THE INFLUENCE OF TEMPERATURE ON SUGAR CONCENTRATION OF THE TUBER IN RELATION TO BACTERIAL SOFT ROT

Potatoes were placed at the following approximate temperatures on the 26th of February, 1944. 4°, 13°, 22°, 30°, and 40° C. On the 7th of March, a sample of tubers was taken from each storage temperature for total and reducing sugar analyses, pH determinations of the juice, and bacterial inoculation of potato slices. Comparable tubers from each storage temperature were given the sublethal heat treatment and submitted to the same tests. The combined data from these experiments are presented in table 1.

The greatest total sugar concentrations were in the juices of potatoes stored at the two extreme temperatures, 4° and 40° C. A minimum sugar concentration was in the potatoes stored at 30° C The sublethal heat treatment caused this minimum sugar concentration to shift to the potatoes previously held at 22° C The short heat treatment did not cause a major shift in the sugar concentration as had been expected. The greater concentrations below 22° to 30° C are in agreement with earlier published data (1, 13, 14, 3, 4)

The hydrogen-ion concentration maintains an inverse relationship to the reducing and total sugars. This relationship holds for both the stored and sublethal treated tubers. The increase in hydrogen-ion concentration of juices from potatoes stored below 22° C is in agreement with Thornton's data (12).

Bacterial infection of tuber slices does not agree with the sugar concentrations of the juices. For those tubers taken from storage active bacterial infection developed only on slices of potatoes previously held

TABLE 1. *The effect of temperature treatment on the sugar content and pH of potato juice, and the infection of slices of potatoes stored for 10 days at various temperatures.*

Storage Temperature °C	pH of Juice	Average of Duplicate Sugar Analyses, Mgm/cc of Juice*: Reducing	Total	Bacterial Growth on Potato Slice: Isolate No. 29	Isolate No 43
	Analyses Following Storage				
4	5 19	8 81	16 11	—	—
13	5 16	6 76	9 86	—	—
22	5 24	6 06	8 36	—[1]	—[1]
30	5 32	3 86	7 89	—[1]	—[1]
40	4 98	4 76	16 88	+	+
	Analyses after Sublethal Treatment Following Storage				
4	5.10	6 21	16 28	+	+
13	5 18	5 05	8 02	+	+
22	5 33	3 03	5 72	+	+
30	5.15	3.72	8 12	+	+
40	4 90	5.15	17 11	+	+

[1]Growth progressed in localized spots, but stopped before 24 hours had elapsed
— Means no infection in 24 hours
+ Means infection in 24 hours
* No appreciable differences occurred between duplicate analyses

at 40° C. The potatoes stored at 4° C had approximately the same sugar concentration as those held at 40° yet they did not become infected Bacterial infection was short lived or did not occur on the slices from potatoes held at the remaining temperatures In contrast, bacterial infection proceeded with vigor on all slices from potatoes receiving the sublethal treatment following storage. The sugar content of the juices from these tubers was not far different from that of potatoes receiving only the storage treatment These data indicate that sugar concentration of the tuber is not correlated with the increased susceptibility following a sublethal heat treatment.

The above experiment was performed again with tubers having the same history except that they were held in storage for 20 days. The potatoes were handled in the same manner, and subjected to the same tests These data are presented in table 2.

In this experiment the greatest total sugar concentrations were again in the juices of potatoes stored at the extreme temperatures, with

TABLE 2. *The effect of temperature treatment on the sugar content and pH of potato juice, and the infection of slices of potatoes stored for 20 days at various temperatures.*

Storage Temperature °C	pH of Juice	Average of Duplicate Sugar Analyses, Mgm/cc of Juice*		Bacterial Growth on Potato Slice	
		Reducing	Total	Isolate No 29	Isolate No 43
	Analyses Following Storage				
4	4.94	8.79	16.38	—	—
13	5.05	5.95	9.77	—	—
22	5.19	3.19	6.82	—	—
30	5.10	3.01	11.59	—	—
40	4.98	3.34	23.14	—[1]	—[1]
	Analyses after Sublethal Treatment Following Storage				
4	5.16	10.75	18.21	+	+
13	5.17	7.29	11.08	+	+
22	5.31	3.43	5.99	+	+
30	5.04	3.29	10.79	+[2]	+[2]
40[1]					

[1]Most of the potatoes stored at this temperature had black heart and there were not enough sound potatoes for this test.

[2]Bacterial growth stopped before or after the elapse of the 24-hour incubation period

*No appreciable differences occurred between duplicate analyses

the minimum concentration in tubers stored at 22° C. The sublethal heat treatment again caused no major shift in sugar concentration The longer storage period affected an increase in total sugars at the higher temperatures The inverse relationship between total sugar concentration and pH was again found in this experiment. Bacterial infection of potato slices again did not agree with the sugar analyses of the juices. As in the preceding experiment the relative sugar concentration of the two sets of tubers was quite similar, yet bacterial infection of the two sets of potatoes was very different. There was no infection of slices from stored potatoes, but all the slices from heated potatoes supported active infection. In the latter case there was an initial infection of slices from potatoes previously stored at 30° C, but this stopped between 24 and 48 hours after inoculation This response had been previously observed on other sublethal treated slices and suggests that the potato tissue stored at this temperature recovers from the heat treatment and stops the pathological activity of the bacteria.

From these experiments it was concluded that changes in the sugar-starch equilibrium within potato cells following storage at various temperatures and sublethal heat treatments could not satisfactorily account for the bacterial infection that repeatedly developed in potatoes given a short heat treatment, and the soft rot observed and experimentally produced under field conditions. Attention was therefore directed to a study of plasma membrane permeability as influenced by storage temperatures and sublethal heat treatment.

Cell Membrane Permeability as Influenced by Temperature and Its Relation to Bacterial Soft Rot

That temperatures from 0° to 30° or 40° C. increase the permeability of cell membranes to water is generally accepted. Permeability to organic and inorganic solutes is also influenced by temperature (6). The degree of change varies with the plant tissue, species, solute, previous history, etc. Since temperature influences solute diffusion through the plasma membrane, the relationship of this factor to diffusion of sugars from tuber cells into the cell walls and possibly intercellular spaces where it would be more readily available to inoculated bacteria was of interest, as sugars are utilized by the soft rot bacteria.

To test the diffusion from tuber cells, a diffusate (2, 11) was prepared and its sugar content analytically determined. The following procedure was used for preparing the diffusate. From 200 to 270 grams of tubers were diced into three millimeter cubes (approximate). The diced tissue was thoroughly washed in six changes of tap water, and then covered with a volume of distilled water equal to its weight. The submerged cubes stood for two hours at room temperature, then the diffusate was poured from the diced tissue, filtered, and made up to the original volume. The diffusate was cleared with 2 c. c. of saturated neutral lead acetate and 6 grams of potassium oxalate. The amount of proteinaceous materials removed was very slight in comparison with the same precipitates from the juices. Duplicate sugar analyses were made on each diffusate. The sugar concentrations of the diffusates were less than the concentrations in the juices, thus requiring a larger sample for chemical analyses.

A preliminary experiment was performed to test the effect of the sublethal heat treatment on the diffusion of sugars. Ten c. c. of diffusate from potatoes held at room temperature for several days contained 0.95 and 1.62 mgms. of reducing and total sugars, respectively. Diffusate from comparable tubers heated to 47° C. for 60 minutes contained 2.28 and 3.89 mgms. of reducing and total sugars. This preliminary test

showed an increase in plasma membrane permeability following the heat treatment

To enlarge on the data from the preliminary test the following experiment was performed. Potatoes were stored at 4, 13, 22, 30, 35, and 40° C. for 14 days A sample of tubers was taken from each storage temperature and diffusates prepared. A comparable sample from each storage temperature was given the sublethal heat treatment before preparing the diffusates Sugar analyses and infection of potato slices are given in table 3

TABLE 3 *Influence of temperature on cell membrane permeability of tuber tissue in relation to bacterial infection. Permeability determined by analyzing diffusates for sugars.*

Storage Temperature °C	Mgm Sugar per 10 c.c. of Diffusate, Average of Duplicate Analyses*		Bacterial Growth on Potato Slices	
	Reducing	Total	Isolate No 29	Isolate No 43
	Analyses Following Storage			
4	1 32	1 58	—	—
13	85	1 58	—	—
22	29	68	—	—
30	48	1 40	—	—
35	59	4 60	—	—
40	8 66	26 90	+	+
	Analyses after Sublethal Treatment Following Storage			
4	2 92	5 97	+[1]	+[1]
13	3 81	6 48	+	+
22	2 13	4 02	+	+
30	93	2 98	—[2]	—[2]
35	56	4 52	—[2]	—[2]
40[3]				

[1]Active infection after 24 hours, but stopped sometime later.
[2]Growth may have started Surface of slice chalky.
[3]Because of blackheart in the potatoes at this temperature there were not enough tubers for this test
*No appreciable differences occurred between duplicate analyses

Plasma membranes of tubers stored at 40° C. were most permeable to sugars Permeability decreased very rapidly to a more or less stable state in potatoes stored at 30° C. and below, with a suggested minimum permeability at 22° C This minimum at 22° C. may be due to the

lower sugar content of the cell sap as suggested by the sugar analyses of the juice This suggestion is refuted, however, when one considers the diffusion from comparable tubers receiving the sublethal heat treatment. Permeability was markedly altered by the sublethal treatment. Those potatoes stored at 4° to 22° C showed a four- to six-fold increase in permeability to total sugars, those at 30° C, a two-fold increase; and those at 35° C. no increase.

Bacterial infection of potato slices was also in agreement with the total sugar concentration of the diffusate. Slices from potatoes stored at 40° C were the only stored potatoes susceptible to the soft rot bacterium as was the case in table 1. In the present experiment the cellular tissue of these tubers was very permeable to the diffusion of sugars. The diffusion of sugars from potato tissue held to 35° C. appears to be on the threshold of supplying enough sugar for bacterial infection. Tubers stored at this temperature and given the sublethal treatment had about the same permeability, and a slight initial bacterial infection started. This infection stopped before the 24-hour incubation and infection period had elapsed. Cell membranes of potatoes stored at 30° C. and receiving the sublethal treatment were less permeable than those stored at 35° C. Here again, bacterial infection had stopped before the 24-hour period had elapsed. Apparently cell membrane permeability of potatoes stored at temperatures progressively above 30° C. for prolonged periods of time is less and less affected by a short sublethal heat treatment.

On the basis of this experiment, greater susceptibility of potatoes held at high temperatures or following a heat treatment is associated with an increased cell membrane permeability to sugars. Sugars possibly diffuse into the cell walls and intercellular spaces making a more suitable environment for the establishment of a pathological relationship by the bacteria.

The permeability data are in agreement with data from field experiments conducted in 1942 and 1943. Freshly-packed potatoes were held at various temperatures and the development of soft rot noted. The tests were performed in a chamber 40 x 40 x 72 inches constructed of 5-ply wood The chamber was equipped with a circulating fan, heater, and thermostat. Owing to the unavailability of precision thermostats, the improvised instrument used left much to be desired in temperature control. For each experiment, temperature varied from 3.3 to 4° C. over a four-day period. Since the fluctuations occurred at more or less regular cycles, the mean temperature of each experiment is used in presenting the data The lowest temperature at which the chamber could be operated was the prevailing air temperature. In 1942, the lowest

temperature was 27 0° C., and in 1943, 29.7° C. The relative humidity in the chamber during the tests ranged from 94 to 98 per cent for all temperatures

Crates of healthy tubers were taken from recently graded and packed bags The crated potatoes were held in the temperature chamber for four days, and examined for bacterial soft rot Infected tubers were recorded according to the inoculation court involved, *i. e*, stem end, lenticels, cuts, and skinned or bruised areas. In this discussion only infections initiated at skinned areas and bruises will be considered. These injuries far exceed any others incurred by the harvesting and packing operation of immature potatoes.

The composite data from two years' experiments with potatoes

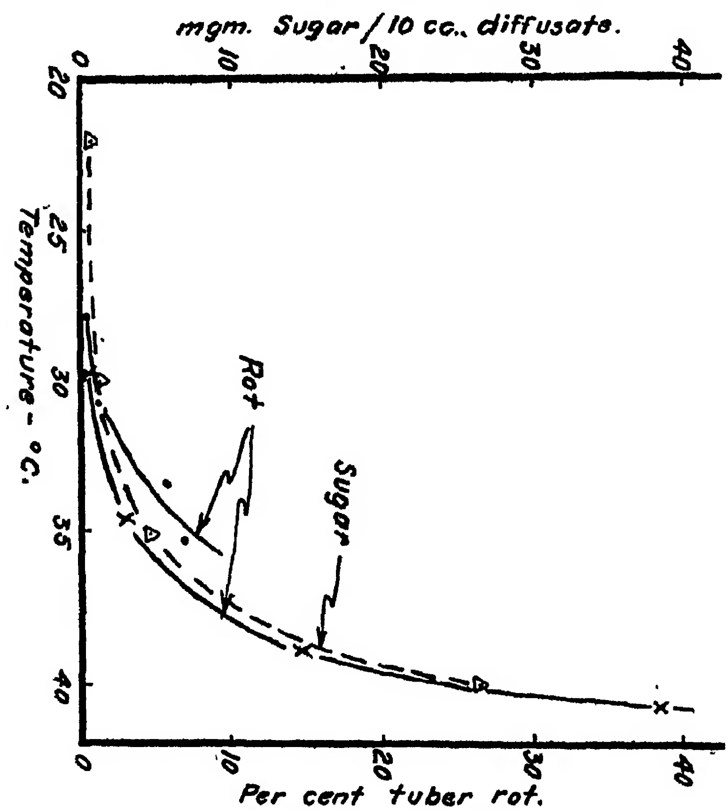

FIGURE 2 Relationship of temperature to soft rot of graded potatoes and diffusion of total sugars from stored potatoes Rot data are presented as solid lines, short line, 1942 data; long line, 1943 data Broken line represents total sugars data from table 3

taken from the graded package are presented in figure 2. The permeability data (total sugars) for the potatoes stored at the various temperatures, table 3, are superimposed on the graph to show the marked parallelism of the three sets of data. For the temperature range examined in 1942 there was more rot than for the same range in 1943. The potatoes used in 1942 were harvested with old burlap bags as the containers In 1943 crates were used. Immature tubers are more severely skinned and bruised when harvested in bags[5] than when harvested in crates, and this is believed to account for some of the difference in the amount of rot for the two harvest seasons The marked similarity of the rot and permeability data in relation to temperature further support the premise that high temperatures increase susceptibility by increasing cell membrane permeability to the outward diffusion of sugars.

In the laboratory studies it has been repeatedly observed that bacterial infection of slices from sublethal heated potatoes may be arrested within 24 hours or longer This suggests that permeability changes induced by high temperatures are reversible The inoculated potato slices were held at temperatures below the optimum for bacterial growth, and the bacteria were possibly unable to continue the pathological relationship after a readjustment of cell membrane permeability. The reversibility of cell membrane permeability and heat-induced susceptibility were demonstrated by a laboratory experiment. Potatoes previously held in the unheated storage room were given the sublethal heat treatment Immediately after the treatment, one-half of the heated potatoes was stored at 18° C. and the other half at 30° C. Reducing sugar analyses were made of diffusates from heated and non-heated potato tissue immediately after the sublethal heat treatment, and approximately 3⅓ and 22¼ hours after heating. Slices of the potatoes were inoculated at the same intervals to test their susceptibility Data from the sugar determinations and infection are presented in table 4.

An examination of the data shows that the potatoes do recover from the increased permeability induced by the heat treatment. Those potatoes held at 30° C recovered sooner than those held at 18° C The permeability continued to increase after the heat treatment was stopped, with greatest permeability developing in those held at 18° C The quantities of reducing sugars found in the diffusates are comparable to similar analyses given in table 3

Bacterial infection of potato slices coincides with increased perme-

[5]Unpublished data

TABLE 4 *Recovery from heat induced susceptibility by potatoes stored at 18° and 30° C following the sublethal heat treatment.*

Heat Treatment	Storage Temperature after Heat Treatment	Reducing Sugars in Diffusates from Potato Tissue, and Bacterial Infection of Potato Slices at Intervals of Time after a Sublethal Heat Treatment					
		Immediately after		3½ Hrs after		22¼ Hrs after	
		Sugar* Mgm/10cc	Bacterial Infection	Sugar* Mgm/10cc	Bacterial Infection	Sugar* Mgm/10cc	Bacterial Infection
None	Room	87	—	.66	—	48	—
47° C for 1 hour	30°C	1 80	+	2 53	+	.60	—
	18°C			2 95	+	1.01	+[1]

*Average of duplicate analyses in which no appreciable differences occurred.

[1]Bacterial infection stopped Heating element in incubator burned out sometime during 72-hour period following inoculation. The cessation of infection may have been due to colder temperature.

ability as shown by the reducing sugar analyses Unfortunately, the temperature control apparatus of the incubator failed during the incubation of those slices prepared after 22¼ hours' storage Some of the slices from tubers stored at 18° C. showed definite symptoms of initial infection, but whether infection stopped before the control apparatus failed is not known.

The reversible nature of heat-induced susceptibility was further demonstrated under field conditions during the 1944 potato harvest On the 20th of June, potatoes were harvested at 8.00 A. M. (E.W.T.) and shaken from the vines to afford a direct exposure to the sun The maximum air temperature for the day ranged about 90° F A sample of potatoes was picked up immediately after digging and taken to the laboratory. At 2·00 P. M the average temperature of the exposed potatoes had reached 48.3° C., about one centimeter within the tubers, and one bushel was carefully picked up to avoid skinning or bruising, taken to the laboratory and held at room temperature. At various intervals after collection, slices from 12 tubers were inoculated to test their susceptibility. This was continued for 45 hours after the 2.00 P. M collection on the 20th of June. The data from this experiment are summarized in table 5

TABLE 5 *Recovery from heat induced susceptibility as demonstrated by bacterial infection of inoculated potato slices at various intervals of time after direct exposure to sunlight.*

	After Digging	After Removal from Sun 48.3° C.	Hours after Removal from Sun		
			8	24	45
Bacterial Infection	0/12*	12/12	8/12	0/12	0/12

*Numerator, slices infected; denominator, slices inoculated.

These data clearly indicate that heat induced susceptibility is a temporary, reversible process. When also considering the permeability data, increased susceptibility is closely correlated with cell membrane permeability. This may be the physiological change caused by sublethal temperatures that increases the susceptibility of potatoes to bacterial infection

Discussion

The reversible nature of heat-induced susceptibility as shown by the above data is supported to some extent by other published data. Peacock *et al* (8) and Nielsen (7) have presented data showing that heated potatoes left on the ground overnight and picked up the following morning rot less extensively than potatoes picked up during or very soon after the exposure to sunlight Had the potatoes in these cases been shaded for additional time before they were wounded in the picking and grading operations, they might have recovered sufficiently to resist bacterial infection

At the present time it is impossible to explain why potatoes continue to rot, if they are capable of recovering from the induced susceptibility This question poses an interesting problem for further study The persistent development of bacterial soft rot in potatoes that have once become infected, even under adverse temperature conditions, suggests that the pathogen, after establishing a pathological relationship, is capable of overcoming the reversion of cell membrane permeability and continuing its pathological activity. This suppression of physiological resistance may be accomplished by the metabolic products of active bacterial growth or the external enzyme system of the pathogen These systems may accomplish permeability or other changes that were originally achieved by sublethal temperatures Should further study substantiate such a pathological relationship for the ingressing bacteria, it would then appear that the heat-induced susceptibility permits the initiation of active infection, after which the pathogen can perpetuate pathological activity even though the heated potatoes tend to recover from induced susceptibility.

Conclusions

The reducing and total sugar concentrations in the cell sap (juice) of potato tubers was found to be greatest in those tubers stored at 4° and 40° C The sugar concentration of potatoes was not correlated with the heat induced susceptibility.

An inverse relationship was found to exist between hydrogen-ion concentration and total sugar concentration of the juice over the temperature range of 4° to 40° C

Cell membrane permeability was found to increase at high storage temperatures and following sublethal heat treatments. The increase in permeability under these conditions is in close agreement with field and laboratory bacterial soft rot data obtained from similar temperature treatments The increase in cell membrane permeability is believed to

play a part in bacterial infection of potatoes by permitting the diffusion of sugars (and probably other nutrients) into the cell walls and intercellular spaces where they are more accessible to soft rot bacteria when the latter are inoculated artificially or naturally through wounds.

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POTATO SPROUTING INHIBITED BY THE USE OF ALPHA-NAPHTHALENEACETIC METHYL ESTER

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Some of the most interesting developments arising from plant science investigations during the past relatively few years, have resulted from the studies of plant growth regulators or hormones Through the use of such materials, the time required for the rooting of cuttings can be shortened, apple dropping delayed, tomato flowers caused to set without being pollinated, blossom drop in wax beans decreased, plants can be killed (weed killer), and the dormant (or rest) period for many plants shortened or extended as desired. Of the above uses, perhaps the one dealing with the extension of the rest period holds the greatest practical interest for most potato growers, since the sprouting of potatoes during the storage period is frequently responsible for rather heavy losses. Such losses result not only from labor costs in removing the sprouts, but from loss in tuber weight incurred from sprout production and maintenance

During the past few years (since 1938) workers at the Boyce Thompson Institute for Plant Research (2, 3, 4, 5) have conducted much investigational work regarding the effect of various chemicals on potato sprouting. Among those, alpha-naphthaleneacetic methyl ester was proven to be the most effective in suppressing sprouting, although indolacetic acid, the potassium salt of this acid and alpha-naphthylacetate showed definite suppressive activity. Thomas and Riker (6), in 1944, working in Wisconsin, and Daines and Campbell (1943-1944) in New Jersey have corroborated some of these findings

From an investigation to determine the effect of alpha-naphthaleneacetic methyl ester on the sprouting of potatoes, Denny and associates report that

"Potato tubers (*Solanum tuberosum L.*) in lots of 20 bushels each, placed in wooden bins shortly after harvest, were exposed to the vapor of the methyl ester or alpha-naphthaleneacetic acid ($C_{10}H_7CH_2COOCH_3$) incorporated into paper towels which were interspersed evenly among the tubers in the bins. An amount of the methyl ester equal to 100 mg per kg. of tubers inhibited completely the sprouting of the tubers from the 3rd of October, 1941 (shortly after harvest) until the end of the experiment, on the 6th of May Only a few sprouts were formed by tubers treated with 33 mg per kg The storage

temperature was 10° to 15° C from the 15th of November to the 15th of April, ranging up to 22° to 23° C in the intervals previous to and subsequent to these dates. Control tubers sprouted freely under the same conditions.

"A similar treatment starting on the 8th of December, 1941 with 50 mgs per kg using tubers that were practically out of the natural dormant period at the time, successfully inhibited sprout development until the end of the experiment.

"Treatments applied to tubers stored in triple-walled paper bags (50-lb capacity), using the same concentrations of chemical at the same temperature and over the same interval, gave responses about the same as those obtained with treatments in bins, provided that the paper towels impregnated with the methyl ester were distributed among the tubers When the chemical was applied only to the inner layer of the paper bag itself, or to paper towels placed on top of the tubers in the paper bag, inhibition of sprouting was obtained only with the tubers touching the sides of the bag, or in the layer of tubers just below the paper towels.

"When the methyl ester of alpha-naphthaleneacetic acid was incorporated into talcum powder which was then applied as a dust to the surface of each tuber, sprout inhibition was obtained at the rate of only 25 mg of methyl ester per kg. of tubers"

Experiment — 1943

In an experiment conducted in New Jersey, designed to determine the value of the methyl ester in home storage, Katahdin potatoes were packed into baskets, the sides, tops and bottoms of which were lined with newspapers. The methyl ester was dissolved in alcohol sprayed on paper towels which towels, after drying, were cut into strips. These strips were distributed evenly throughout each basket of treated potatoes. The amount of ester used equalled 36.7 mgs per kg or 1 gr per bushel of potatoes. The potatoes were then stored in two home basements and held from January, 1943 until April of that same year. During this storage period the temperature in each basement varied between 14° and 21° C. At the end of the four-month storage period the potatoes were desprouted and weighed. During this period untreated potatoes produced sprouts at the rate of 2090 grams, whereas treated potatoes produced sprouts at the rate of 501 grams per bushel. At the time this test was terminated, most of the untreated potatoes were so shriveled they were considered unusable. At this same time the treated potatoes, even though somewhat shriveled, were still good for table use.

TABLE 1—*Comparative effectiveness of alpha-naphthaleneacetic methyl ester deposited on paper strips and talc in preventing potatoes from sprouting.*

Quantity of Ester Used per Kg. of Potatoes and Method of Application	Grams of Sprouts per Bushel of Potatoes
1 Untreated	1896
2. 50 mg* of the ester deposited on paper strips	327
3 50 mg of the ester deposited on talc	47
4 25 mg of the ester deposited on talc	297

*50 mg of ester per kg of potatoes equals 1 36 grams per bushel

EXPERIMENT — 1943 - 1944

In September, 1943 freshly harvested Katahdin potatoes were treated with a dust preparation (talc) carrying the methyl ester As a comparison Katahdin potatoes were treated with paper towel strips on which the ester had been deposited All the potatoes were then stored in a home basement in baskets that had been lined with newspapers In February, 5 months after the beginning of the experiment, the potatoes were removed from the baskets, desprouted and weighed During this period the untreated potatoes produced sprouts at the rate of 1896 grams per bushel Those potatoes which were treated with the ester deposited on paper towels and used at the rate of 50 mgs of the ester per kg of potatoes produced 327 grams of sprouts, whereas the potatoes treated with the ester, deposited on talc at the rate of 50 and 25 mgs per kg., produced 47 and 297 grams of sprouts, respectively. In this test 25 mgs of ester applied as a dust was equal to 50 mgs of the ester applied on paper strips and distributed throughout the potato pack.

TUBER INJURY

Denny reports that in one experiment from 5 to 19 per cent of the potatoes that received an alpha-naphthaleneacetic methyl ester treatment after their dormant period had terminated, showed an unusual type of injury The symptoms observed consisted of hard lump-like growths in the potato tissue, usually at the apical end Affected tissue becomes dark on aging

This same type of injury was reported by Thomas and Riker and was observed in a test on cobbler potatoes in New Jersey It may be

significant that in each of the three cases reported, where injury resulted from the treatment with the ester, that the potatoes had passed their dormant period before treatment.

Effect on Germination

Because many of the sprouts that developed on potatoes that had been treated with alpha-naphthaleneacetic methyl ester, appeared very similar to the abnormal sprouts that we have called "blind sprouts," producd in occasional fields, some of the treated potatoes were cut into seed pieces and later planted. This was done to determine whether or not "blind sprout," as it occurs in the field, could be produced in this manner The treated seed pieces germinated very poorly,—even after two months duration.

Conclusions

Alpha-naphthaleneacetic methyl ester successfully inhibited sprouting on the Katahdin and Cobbler varieties of potatoes

The above mentioned ester was more effective when applied as a dust, than when distributed throughout the potato pack on paper strips.

From these experiments it appears that from ⅔ to 1⅓ grams of the ester should be used (on a dust) for the treatment of each bushel of potatoes The amount to be used may vary somewhat with the temperature at which the potatoes are stored

Injury followed the use of the methyl ester in one test.

Potatoes to be used as seed should not be treated with alpha-naphthaleneacetic methyl ester.

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THE AMMONIUM THIOCYANATE TREATMENT FOR HASTENING THE SPROUTING OF DORMANT BLISS TRIUMPH POTATOES

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It has been recognized for several years (3) that it is necessary to treat potato seed pieces to hasten sprouting when dormant seed stocks are used for planting. In the Everglades area the seed stocks received from the north for early fall planting are dormant, as also are the home-ground stocks sometimes used to plant the spring crop. Denny (1) (2) was the first to develop successful chemical treatments which would force dormant potato seed pieces to sprout. Following his suggestions we (3) have adapted the ethylene chlorhydrin treatment to the needs of Everglades potato growers in experiments covering a period of 13 years. Denny (1) (2) also had forced sprouting of dormant tubers by soaking cut seed pieces in solutions of the sodium, potassium and ammonium thiocyanates. These treatments have not been regarded favorably, first, because the sodium and potassium thiocyanates have sometimes caused the seed pieces to rot, and secondly, because soaking for an hour is inconvenient for extensive operations.

Experiments were begun in 1942 to determine whether the ammonium thiocyanate treatment could be adapted to local needs. In that year it was learned that soaking freshly cut seed pieces in 1 and 1½ per cent solutions of ammonium thiocyanate for one hour was likely to cause the seed pieces to rot. Likewise, instant dipping of the seed pieces in 2, 2½ and 3 per cent solutions was injurious. It was found however, that freshly cut seed pieces could be dipped safely in ½ and 1 per cent solutions of ammonium thiocyanate, and that the seed pieces would sprout earlier when so treated.

In 1943 it was found that the best results were obtained when ¾ per cent or 1 per cent solutions of ammonium thiocyanate were used. It made little difference whether freshly cut or calloused seed pieces were treated. The stands and yields were better when the treated seed pieces were not planted immediately, but were allowed to stand for 18 to 20 hours. The percentage of seed pieces sprouted and the yield of tubers with this treatment compared favorably with the ethylene chlorhydrin treatment.

The experiments in 1944 confirmed the earlier work, and showed that although ammonium thiocyanate-treated seed pieces sprouted some-

TABLE 1—*Percentage of seed pieces sprouted and yield in potato seed treatment experiment.*

Planted Sept. 23, 1943

Treatment	Per cent Sprouted	Bushels per Acre
None	67.3	112
1:75 Ethylene chlorhydrin	91.8	227
1 per cent Ammonium thiocyanate	95.5	224
Least significant difference	8.1	48

what more slowly than did the ethylene chlorhydrin-treated seed pieces, the final stands and yields were equal to, or better than, those obtained by using ethylene chlorhydrin. Both treatments forced early sprouting, increased the final stand, hastened maturity and increased the yields.

Seven growers made field trials of the ammonium thiocyanate treatment in 1944. Each of the growers obtained better stands with this treatment than with the 1:75 ethylene chlorhydrin dip treatment. The yields on these plots were compared by four growers who found that they obtained, on the average, forty additional bushels per acre with the ammonium thiocyanate treatment.

The ammonium thiocyanate treatment is recommended to growers on the basis that it gives as good or better results than ethylene chlorhydrin; that it permits a more convenient schedule of operations; and that it is safer to use. Furthermore, it appears that potatoes grown with this treatment generally produce a cleaner crop than those grown from ethylene chlorhydrin-treated stock. This is apparently due to an effect on potato scab which is still being studied, and which will be reported in a later paper. The hot formaldehyde treatment for scab should not be omitted when this dormancy treatment is used.

The ammonium thiocyanate treatment as recommended is quite simple. The boxes of freshly cut seed pieces should be dipped for an instant in a solution containing 3 pounds of ammonium thiocyanate in 50 gallons of water. After dipping, the excess solution should be allowed to drain back into the tank and then the boxes may be stacked overnight. The treated seed should be planted the following day. As with the ethylene chlorhydrin treatment, it is best to treat late in the day to obtain the advantage of temperatures below 80° F. and to stack the boxes of treated seed so that they are protected from the sun, wind or rain,—but with some ventilation. An open packing shed platform is a suitable site for the operations involved.

Fifty gallons of the treating solution is enough for the treatment of 100 boxes of potatoes. When larger quantities of potatoes are to be treated, it suffices to add more of the treating solution to the tank as it wastes away and becomes too low to submerge the boxes. The dirty solution should be disposed of after each day's run of treatments. Since the solution is corrosive to metal, wooden tanks and boxes should be used The chemical and waste solutions should be carefully disposed of since they are slightly poisonous if taken internally by men or animals.

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SECTIONAL NOTES

ALABAMA

The Irish potato crop for the Gulf Coast area of Alabama was planted this year in record time. Unfavorable weather during December and January and a car shortage had promised difficulty in getting the crop planted on schedule. Favorable weather during late January and February permitted the crop to be planted by the middle of February The crop is, therefore, somewhat ahead of normal.

The early plantings are breaking the ground and are being covered to avert danger of frost at this season.

Approximately 22,000 acres have been planted in Baldwin, Mobile, and Escambia counties, Baldwin County accounts for 17,000 acres. Approximately one-third of the total acreage is planted to the Sebago variety and the rest to Triumph.

The quality of the seed has been excellent Weather conditions continue to be good. Adequate labor has been available for planting, but a labor shortage is expected during the height of the harvest season. (March 2)—L M. WARE and FRANK GARRETT

IDAHO

Earlier in the winter season, the potato movement was materially retarded because of a shortage of refrigerator cars However, considerable slack has been taken up during the past few weeks The shipments

to date total slightly over 31,000 cars as compared with less than 29,000 a year ago,—a difference of more than 2,000 cars. Even so, it is questionable that Idaho has shipped the same percentage of the 1945 crop as it had shipped of the 1944 crop a year ago.

A rather unfavorable situation developed from the producers' standpoint during the period of car shortage in that the spread between the price received by the grower and the price received by the dealer was much greater than normal. The car shortage created a demand that couldn't be satisfied.

Had it not been for the support price and the fact that a number of growers took the potato loan, prices would undoubtedly have dipped somewhat lower. Prices have ranged mostly from $1.75 to $1 85 (bulk) per hundred weight to growers. At present, $2.00 to $2 10 is being offered quite freely with a stronger bid for later delivery. Earlier in the season the feeling was quite general that Idaho might find it difficult to market the crop before the early deal in California got into full swing. The situation has changed during the past two weeks and both growers and dealers are taking a more optimistic point of view.

Sale or contracting seed potatoes has been quite slow compared with the last two years. Considerable stock is still unsold. There appear to be two reasons for the retarded sale The 1945 certified crop was approximately 50 per cent larger than 1944 and the intentions for planting in 1946 indicate some reduction in acreage. The recommended crop goal by the AAA calls for 161,000 acres of potatoes which is 46,000 less than the 1945 acreage Although the acreage to be planted in 1946 is likely to exceed the crop goal recommended, the final figures will undoubtedly show a marked reduction in acreage as compared to 1945. As a result of the decreased demand for seed, considerable seed stock carrying good size, has entered the commercial market. This is regrettable for there are still quite a few commercial growers that could profit by planting better seed. However, with the stronger feeling in the commercial production, the demand for certified seed potatoes should become more active (Mar 1)—JOHN L. TOEVS

INDIANA

There is an ample supply of good quality potatoes on our markets These potatoes have come from various parts of the country The demand has favored Indiana potatoes which meet the competition from other states Our growers do a good job of grading, cleaning and bagging now since they found that an attractive display brings repeat sales. Consumers are now turning from the 100-pound bag to the smaller

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sizes and I look for more sales to be packed in 25 to 30-pound containers. The planting season will start this month in southern Indiana, —with Irish Cobbler predominating and a few Bliss Triumph There is a good demand for certified seed which should continue until the late plantings are in, and until the latter part of May (Feb. 26)—W B WARD.

MAINE

Three potato mass meetings called in Aroostook County recently, to inform farmers of the work done by the Experiment Station on DDT, were attended by 1,000 farmers Local meetings held in other communities have resulted in a large atendance, for Aroostook potato growers are interested in the possibilities of DDT for 1946 It will be recommended for table stock growers.

The general quality of Maine certified seed should be especially good this year, judging from Florida tests which indicate the amount of disease spread that took place during the growing season These Florida tests show that disease spread, in general, in Maine was lighter than normal. As of March first supplies of seed in Maine are not heavy but apparently sufficient to take care of buyer's requirements. Purchases of Cobblers, Katahdins and Sebagos have been somewhat lighter than normal to date, and Green Mountain purchases have been exceptionally light It is expected that seed purchases will be very heavy during the month of March Good supplies of foundation seed are available for planting here in Maine and Maine will certainly not be handicapped by lack of good seed for the coming crop

Two thousand, six hundred and ninety-two potato loans were made by the Commodity Credit Corporation under the support price program This work is being handled by the Conservation Association Approximately $15,250,000 was loaned on approximately 27,707 cars which is about one-half the crop Already about two-thirds of this money has been paid back indicating that many farmers took the loan, not because they needed the money, but so they would be assured of support prices Aroostook County has made about 85 per cent of all the Commodity Credit loans in the Northeast

The month of February was one of many snowstorms This resulted in a fairly serious car shortage. Because of the weather Eastern markets are very low on supplies and this has strengthened the market considerably Maine has shipped about 34,000 cars of potatoes as of March 1. This compares with last year's total of 32,500

The Brewster Bill is being generally discussed throughout the

county Maine growers feel that some price support is desirable and to secure price support they are willing to enter any acreage control program which appears practical. (Mar 2)—VERNE C. BEVERLY

NEW JERSEY

Our season is very advanced and most growers have already plowed a large portion of their acreage Several growers started their planting operations on the 12th and 13th, and have a fair portion of thir potatoes planted Other growers are not willing to take the risk of having their crop frozen, and are therefore waiting until the danger of severe freezing is past

There is a serious shortage of seed because most of the available cars in Maine are being used for the shipment of table stock Table stock is now commanding a relatively high price. If a priority is not issued immediately for the shipment of seed stock to New Jersey and other intermediate areas, our potato acreage might be considerably reduced

The shortage of fertilizer materials,—especially sulfate of ammonia and potash may also tend to further reduce the total acreage planted in New Jersey this year (Mar 18)—J C CAMPBELL

OREGON

Inspection of certified and foundation potato seed at Oceanside Nursery, California, is of great interest to growers in this section Many growers of certified seed attended the meeting at Oceanside, examining seed samples from certified growers of the Western states More than thirty growers attended from his area, traveling nearly 1,000 miles to view the seed samples growing out of doors in the Nursery. This is indicative of excellent interest in the seed program There is considerable interest here in further disease control work of potatoes in the State of Oregon and particularly in Klamath County.

Potato shipments have been held up because of car shortage and shipments to date indicate that shipping will continue until April. Preliminary information indicates some decrease in commercial acreage with greater interest in the securing of improved seed (Feb 27)—C A HENDERSON

SOUTH CAROLINA

Potato planting started on schedule on the 1st of February and has proceeded with unexpected speed Practically all the seed will be in the soil by the end of the month and most of it was in by the 23rd of February. Weather conditions have been better than normal during February.

Unless there is a drastic change in soil moisture within the next few days, we should have an excellent stand. Examination on the 25th of potatoes planted on the 4th revealed sprouts 3½ to 4 inches in length. This would indicate early emergence which may not be helpful Judging by cabbage, lettuce, and fruit trees, the season is only 2 to 4 days later than last year,—which was early If normal frost dates prevail in early March, there may be some damage to potatoes.

Pre-season acreage predictions indicated a 5 to 8 per cent increase This may extend from 8 to 12 per cent because of the fact that smaller size seed potatoes have resulted in the use of 5 to 7 per cent less seed per acre than normal. In many cases this extra seed will be planted; thereby increasing acreage slightly more than indicated. Apparently all the increase in acreage will be in the Charleston-Beaufort area which is the chief production area. (Feb. 25)—W C BARNES.

SOUTH DAKOTA

Growers are loading from 10 to 20 cars a day now in an effort to clear their warehouses before planting time A good market for certified cobblers had developed and most of the stock is now sold Prices have ranged from $2.20 to $2 40 per hundred. Table stock and certified Triumphs are moving slowly Probably one-half the shipments in January and February were for the C C C. on loan potatoes A few sealed bins are going out of condition, but most of the stock is keeping well.

The reliable growers will plant as many potatoes as last year, and an increase in acreage is expected by some forecasters. Our total acreage may be slightly less than in 1945. Growers are generally satisfied with loan prices F O. B the farmer's gate,—as announced for the 1946 crop Our growers have made money during the war years. They now have modern machinery and will carry on at present prices (March 3) —JOHN NOONAN

TEXAS

Planting of potatoes has been delayed in the Lower Rio Grande Valley because of continued rains during January and the early part of February. Planting was not completed until the last week in February,—which is late planting for this region.

Growth conditions have been favorable during the latter part of February and early plantings have made good progress. An infection of late blight has been found in the principal production area in the Valley, which might conceivably develop into an epidemic such as that experienced during the 1945 spring season. (Feb 27)—W H FRIEND

—Facts from the Source— PAGE 3

INCREASED POTATO YIELD FOLLOWS USE OF DDT INSECTICIDE FORMULA

The formulation of Geigy DDT insecticides marks a great stride forward in "bug" control.

Actual field tests on potatoes, where GESAROL* DDT compositions were used for control of insects, increased productio**n** from 80 bbls. per acre to 140 bbls. In another case, 1051 bbls. of potatoes were harvested from 5 acres.

HOW TO USE GESAROL AK 50

Use GESAROL AK 50 . . . it may be combined with your fungicides and applied in the regular spray schedule If you prefer to dust, Geigy has GESAROL VD 50 which processors should use in making your mixed dusts.

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PROGRAM OF THE TWENTY-NINTH ANNUAL MEETING of the POTATO ASSOCIATION OF AMERICA March 28-29, 1946 St. Louis, Missouri

President, EARL B TUSSING, *Ohio State University, Columbus, Ohio*

Secretary, WILLIAM H MARTIN, *Rutgers University, New Brunswick, N J*

Thursday Morning Joint Session with American Society for Horticultural Science, March 28, 9 30 a m ; Parlor B, Lennox Hotel

EARL B TUSSING, *Presiding*

1. *The Ascorbic Acid Content of Nebraska Grown Potatoes as Influenced by Variety, Environment, Maturity, and Storage* (10 min, lantern) H O. WERNER and R. M LEVERTON, University of Nebraska

2 *Methods of Application of Fertilizers to Potatoes.* (15 min, lantern) ORA SMITH and W C KELLY, Cornell University

3 *Specific Gravity and Quality in Potatoes* (10 min) ORA SMITH, Cornell University.

4 *Improving Skin Color of Potatoes* (10 min) ORA SMITH. Cornell University

5 *The Effect of Nitrogen, Phosphate, Potassium and pH on Yield of Red McClure Potatoes as Determined by Soil Analysis and Fertilizer Application* (15 min) W C SPARKS, Colorado A & M College.

6. *Three Years' Experiments with DDT against Potato Insects* (15 min, lantern) A. A. GRANOVSKY, University of Minnesota

7 *Results of Rapid Tissue Tests as Indicators of Potato Yields.* (10 min.) ORA SMITH and W C. KELLY, Cornell University.

8 *Preliminary Report on the Periods of Critical Need of Potatoes for Nitrogen and Potassium* (15 min.) E M. EMMERT, University of Kentucky

9. *Retarding Sprout Growth of Potatoes and Root Crops in Storage* (15 min) ORA SMITH, M A BACZA and J H ELLISON, Cornell University

10. *The Effect of Irrigation and Quantity of Fertilizer in Potato Yields with Different Fertilizer Placements* (15 min, lantern) E J WHEELER and J M TYSON, Michigan State College.

Thursday Afternoon Session, March 28, 2·00 p m ; Parlor B, Lennox Hotel

EARL B TUSSING, *Presiding*

11 *The Influence of Fertilizers on the Yield and Specific Gravity of Alaskan Grown Potatoes* (20. min) ZOLA M FINEMAN, Minneapolis, Minn.

12 *Study of Weight Losses in Two Types of Consumer Packages* (10 min, lantern) EARL B TUSSING and E K ALBAN, Ohio State University

13 *Five County Potato Spray Projects* (15 min) G H BERKELEY, R W THOMPSON and J. K. RICHARDSON, Dominion Laboratory of Plant Pathology, St Catherines, Ont

14. *The Work of the National Potato and Onion Committee* (15 min, lantern) C L. FITCH, Ames, Iowa

15 *Some Ecological Factors in Potato Production* (20 min, lantern) JOHN BUSHNELL, Ohio Agricultural Experiment Station, Wooster, Ohio

16. *Certification Standards for Seed Potatoes* (20 min) MARX KOEHNKE, Alliance, Nebr

17. *Potato Varieties Grown in North Dakota in 1945* (7 min) HAROLD MATTSON, North Dakota Agricultural College

Friday Morning Joint Session with American Phytopathological Society, March 29, 9 00 a m; Parlor B, Lennox Hotel

18. *A Correlation between Pigment Production and Pathogenicity among the Actinomyces Causing Scab of Potatoes* (10 min, lantern) CARLTON F TAYLOR and PHARES DECKER, West Virginia University

19 *Studies on Rotary-Knife Disinfectants for the Control of Ring Rot of Potatoes* (15 min) W A KREUTZER, GEO H LANE, and J L PASCHAL, Colorado A. & M. College.

20. *The Stationary Double-edge Knife for the Control of Potato Ring Rot* (15 min) J L. PASCHAL, W A. KREUTZER and GEO H LANE, Colorado A. & M College

21 *Corynebacterium sepedonicum in Potato Varieties and Lines Tolerant or Resistant to Ring Rot* (15 min) W A KREUTZER, A O SIMONDS, and GEO H LANE, Colorado A. & M College

American Potato Journal

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NEW BRUNSWICK, N. J

FERTILIZER STUDIES WITH POTATOES*

ORA SMITH AND W. C KELLY

Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

The object of these experiments is to study the effects of (1) several rates of application of 5-10-10 fertilizers, (2) several methods of placement of fertilizers, (3) several combinations of sources of nitrogen and (4) several combinations of sources of potash on (1) concentration in the petiole of the plant of nitrate nitrogen, phosphorus, potash, calcium and magnesium, and (2) yields, and (3) specific gravity of the tubers

PROCEDURE

The Green Mountain variety was grown and was planted May 31, 1944, on Lordstown silt loam soil and harvested October 17, 1944

TREATMENTS.

(A) *Two rates of fertilizer application*
   (1) 1200 lbs. per acre of 5-10-10 fertilizer
   (2) 2400 lbs. per acre of 5-10-10 fertilizer

(B) *Three methods of fertilizer application.*
   (1) all in equal depth bands at planting time
   (2) one-half broadcast then plowed under, one-half in equal depth bands at planting time

*Paper No. 279. Department of Vegetable Crops, Cornell University, Ithaca, New York.

Grateful acknowledgment is made of a grant from the International Minerals and Chemical Corporation, Chicago, Ill, for the purpose of aiding the conducting of these studies.

(3) one-half on plow sole at time of plowing, one-half in equal depth bands at planting time

(C) *Three combinations of source of potash*

(1) all K_2O from muriate of potash (KCl)

(2) one-half of the K_2O from KCl, one-half from sulfate of potash (K_2SO_4)

(3) one-half of the K_2O from KCl, one-half from sulfate of potash-magnesia

(D) *Two combinations of source of nitrogen*

(1) 80 per cent of nitrogen from ammonium sulfate, ($(NH_4)_2SO_4$); 20 per cent from Uramon

(2) 80 per cent of nitrogen from ammonium sulfate, ($(NH_4)_2SO_4$), 20 per cent from ammonium nitrate (NH_4NO_3)

This was a factorial experiment of 2 x 3 x 3 x 2 = 36 treatments Each treatment was replicated twice, resulting in a total of 72 plots Each plot consisted of four rows,—fifty feet in length Yield data and samples for chemical analyses were obtained only from the inner two rows of each plot

The broadcast applications and plow sole applications were made just before or during plowing on the 30th of May Immediately preceding plowing, hydrated lime at the rate of 500 pounds to the acre was drilled over the entire experimental area. The soil reaction before lime was applied was pH 5 0

The sulfate of potash-magnesia used in these experiments is mineral langbenite containing 18 5 per cent MgO and 22 00 per cent K_2O and known in the trade as SulPoMag

Samples of petioles were selected from plants in each of the 72 plots on the 13th and 27th of July; on the 10th and 25th of August, and on the 8th of September for analysis of nitrate nitrogen, phosphorus, potassium, calcium and magnesium The methods of Peech and English (1) were used. Total yields and yields of U. S 1 size tubers were obtained at harvest time. Specific gravity was determined of tuber samples from each of the plots as an indication of their degree of mealiness.

Results

Effects of Rate of Fertilizer Application on Yields The data of tables 1 and 2 and figure 1 show that yields of U. S 1 size potatoes from applications of 2400 pounds per acre of 5-10-10 fertilizer were considerably larger than from applications of 1200 pounds to the acre. How-

ever, these data also show that other factors such as source of potash and method of placement of the fertilizer greatly influenced yields obtained from any one rate of application. This is indicated in tables 2

TABLE 1—*Summary table showing main effects of the various individual treatments on yield of U. S 1 size tubers. Each figure is an average of 24 or 36 plots*

Rate of Application**	U S 1 Size Bu/A
1200 lbs 5-10-10 to the acre	291
2400 lbs 5-10-10 to the acre	343
*Placement***	
All in bands at planting time	293
½ broadcast before plowing, ½ in bands	335
½ on plow sole, ½ in bands	324
*Source of Potash***	
All from Muriate of potash	307
½ from Muriate, ½ from sulfate of potash	292
½ from Muriate, ½ from sulfate of potash-magnesia	353
Source of Nitrogen	
4/5 from Ammonium sulfate, 1/5 from Uramon	319
4/5 from Ammonium sulfate, 1/5 from Ammonium Nitrate	315

**Differences are significant at the 1 per cent point

to 5 For instance, as shown in tables 3 and 5, an application of 1200 pounds of fertilizer to the acre when one-half was broadcast, then plowed under, the remainder applied in bands at planting time, yielded 313 bushels, an application of 2400 pounds to the acre all applied in bands at planting time resulted in a yield of 323 bushels to the acre When 2400 pounds per acre were applied, one-half broadcast, one-half in bands at planting time, the yields were increased to 356 bushels to the acre.

As shown in table 4 source of potash also greatly influenced the yield obtained from any one rate of application of fertilizer For instance, an application of 1200 pounds of fertilizer to the acre with one-half of the potash from KCl, the remainder from sulfate of potash-magnesia, yielded 329 bushels to the acre; likewise, an application of 2400 pounds to the acre with all the potash in the form of KCl resulted in a yield of 329 bushels to the acre. In other words, the sulfate of potash-magnesia, comprising one-half of the potash in 1200 pounds of 5-10-10 fertilizer, was equally influential in increasing the yields of po-

TABLE 2—*Detailed table showing main effects of all treatments on yields of U S. 1 size potatoes.*

Rate per Acre 5-10-10	Methods of Placement	Source of N and K						Average	
		4/5 Ammonium Sulfate 1/5 Uramon			4/5 Ammonium Sulfate 1/5 Ammonium Nitrate				
		All KCl	½ K_2SO_4 ½ KCl	*½ $KMgSO_4$ ½ KCl	All KCl	½ K_2SO_4 ½ KCl	*½ $KMgSO_4$ ½ KCl		
		Bushels per Acre			Bushels per Acre				
1200 lbs	All in bands	260	275	305	232	210	298	263	291
	½ broadcast ½ in bands	311	269	330	322	282	366	313	
	½ plow sole ½ in bands	294	270	327	297	254	347	296	
2400 lbs	All in bands	309	273	364	298	317	375	323	343
	½ broadcast ½ in bands	351	352	389	340	318	386	356	
	½ plow sole ½ in bands	336	352	380	339	333	363	351	
	Average	310	298	349	304	285	356		
	Average		319			315			

*Sulfate of potash-magnesia

TABLE 3—*Effect of rate of fertilizer application and method of placement on yields of U. S. 1 size potatoes as an average of two combinations of sources of nitrogen and three sources of potash.*

Method of Placement	Rate per Acre		Difference
	1200 Lbs	2400 Lbs	
	Bushels per Acre		
All bands	263	323	60
½ broadcast, ½ bands	313	356	43
½ plow sole, ½ bands	298	351	53
Average	291	343	

Least difference at 5 per cent point between rates of application=11 bushels per acre
Least difference at 5 per cent point between methods of placement=13 bushels per acre

TABLE 4—*Effect of rate of fertilizer application and source of potash on yields of U S 1 size potatoes as an average of three methods of placement and two sources of nitrogen.*

Source of K	Rate per Acre		Difference
	1200 Lbs	2400 Lbs	
	Bushels per Acre		
All KCl	286	329	43
½ K_2SO_4, ½ KCl	260	323	63
½ K_2SO_4 ½ KCl	329	377	48
Average	291	343	

**Sulfate of potash magnesia.
Least difference at 5 per cent point between rates of application=11 bushels per acre

tatoes as was an additional 1200 pounds of 5-10-10 fertilizer with all the potash in the form of KCl. However, when one-half of the potash in a 2400 pound per acre application was in the form of sulfate of potash-magnesia, the yields were further increased to 377 bushels to the acre.

Effects of Methods of Fertilizer Placement on Yields. The data of tables 1, 2, 3 and 5 and figure 1 show further that yields of potatoes are greatly influenced by the method of application of the fertilizer. Of the

TABLE 5—*Effect of fertilizer placement, rate of application of fertilizer and sources of nitrogen on yields of U. S. 1 size potatoes as an average of three combinations of sources of potash*

Rate of Application	Placement	Source of Nitrogen: 1/5 Uramon 4/5 $(NH_4)_2SO_4$	Source of Nitrogen: 1/5 Amm. Nitrate 4/5 $(NH_4)_2SO_4$	Average	
		Bushels per Acre			
1200 lbs. per acre	All bands	280	246	263	291
	½ broadcast, ½ bands	303	323	313	
	½ plow sole, ½ bands	297	299	298	
2400 lbs per acre	All bands	315	330	323	343
	½ broadcast, ½ bands	364	348	356	
	½ plow sole, ½ bands	356	345	351	
	Average	319	315		

Least difference at 5 per cent point=26 bushels per acre

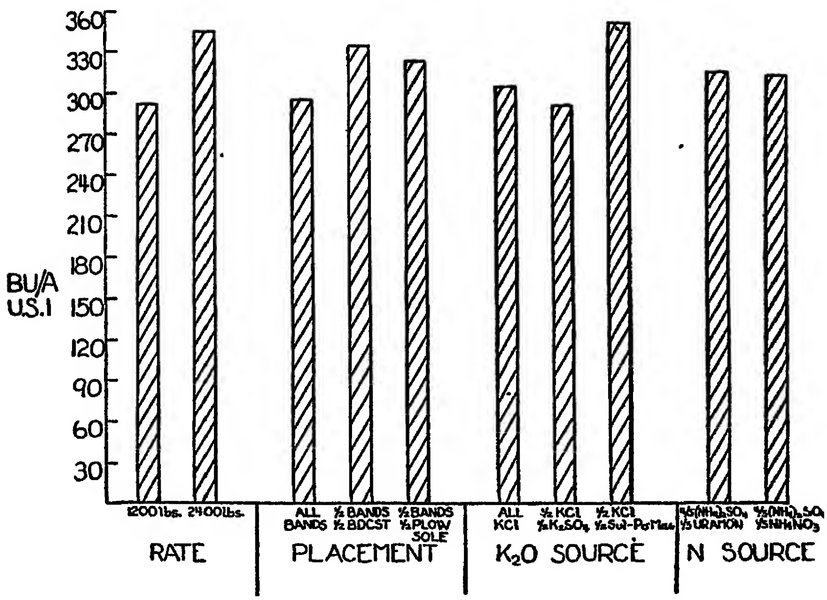

FIGURE 1 Effect of rate and placement of fertilizer, source of potassium and source of nitrogen on yields of potatoes.

three methods employed in these experiments, that of one-half broadcast then plowed and one-half in bands at planting time consistently yielded higher than when all was applied in bands at planting time This latter method is used predominantly by commercial growers in the state These increases in yield ranged from 25 bushels per acre when one-fifth of the nitrogen was Uramon and one-half the potash was sulfate of potash-magnesia to 66 bushels per acre when one-fifth of the nitrogen was NH_4NO_3 and all of the potash was in the form of KCl There was no statistically significant difference in yield between methods of placing one-half of the fertilizer broadcast, then plowed, with the remainder in bands at planting time and that of applying one-half on the plow sole with the remainder in bands at planting time

Effects of Source of Potash on Yields The data of tables 1, 2 and 4 and figures 1 and 2 show that yields of potatoes are further influenced by the source of potash in the complete fertilizer. There are no statistically significant differences in yield between all KCl as the source of potash and that of one-half KCl, one-half K_2SO_4. Of the three combinations of sources of potash used in these experiments that of one-half from KCl, one-half from sulfate of potash-magnesia consistently

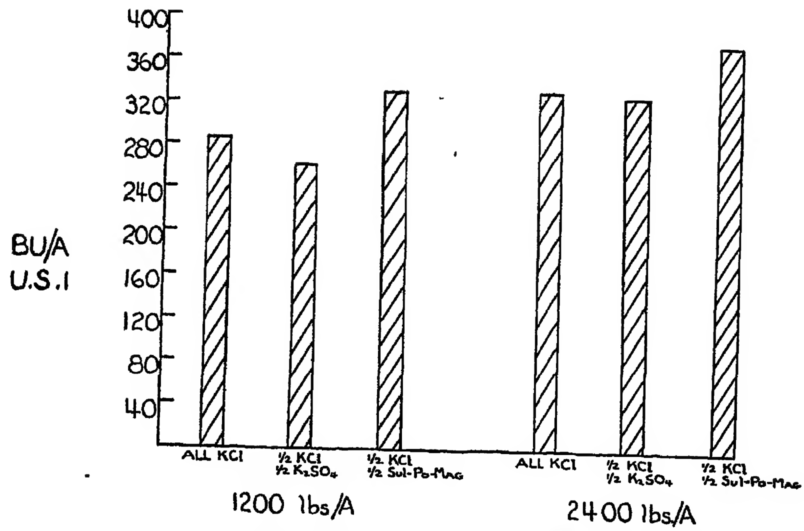

FIGURE 2 Effect of source of potassium at two rates of fertilizer application on yields of potatoes

yielded higher than the other two sources. These increases in yield (Table 2) range from 19 to 77 bushels to the acre. As shown in table 1, the increase in yields from one-half KCl, one-half sulfate of potash-magnesia compared with that of all from KCl as an average of twelve combinations of treatments was 46 bushels to the acre. These differences are highly significant statistically.

Yield increases from one-half KCl, one-half sulfate of potash-magnesia compared with one-half KCl, one-half K_2SO_4 are in the order of those of one-half sulfate of potash-magnesia above 100 per cent KCl, —ranging from 28 to 93 bushels per acre with an increase of 61 bushels to the acre as an average of 12 combinations of treatments The average yield of 12 plots receiving applications of 1200 pounds to the acre with one-half the potash as sulfate of potash-magnesia was 329 bushels U. S. 1 size to the acre and the yield of 12 plots receiving 2400 pounds to the acre, with all the potash as KCl, was 329 bushels to the acre also. Hence, the sulfate of potash-magnesia resulted in as large increases in yield as did an additional application of 1200 pounds of 5-10-10 fertilizer with the potash as KCl

Further evidence indicating that the increases were due to the magnesium content of the potash source is shown in a later section on analyses of the leaf petioles of the various treatments

Effects of Source of Nitrogen on Yields. The data of tables 1, 2

and 5 and figure 1 show that difference in yields of potatoes was not influenced to a statistically significant amount by sources of nitrogen employed in this experiment when all of the 18 combinations of treatments are averaged

Rate of application and method of placement of fertilizer may have an influence on the relative yields obtained from various sources of nitrogen as indicated below At the 1200-pound per acre rate of application, all placed in bands, Uramon treatments yielded higher than NH_4NO_3 treatments However, by changing the method of fertilizer placement so that one-half is broadcast then plowed, one-half in bands instead of all in bands, then NH_4NO_3 treatments yielded higher than Uramon treatments. These examples indicate that there are certain combinations of sources of nitrogen, rate of application and methods of placement of fertilizer which are more desirable than others

Interactions

The data of tables 3 and 4 show respectively the significant first order interactions between the factors of rate x placement and rate x source of potash In the rate x placement interaction, each factor appeared to reduce the effect of the other. This suggests that to some extent each could replace the other The greatest increase in yield from the 2400 pound per acre rate of application over the 1200 pound rate resulted when all the fertilizer was placed in bands; least increase when one-half was broadcast and plowed under, and the remainder placed in bands The greatest increase from methods of application resulted when one-half was broadcast and plowed down, the remainder being placed in bands compared with that of all in bands This was the case at both the 1200 and 2400 pound per acre rates of application

The rate x source of potash interaction was of a similar nature to the rate x placement interaction. The greatest increase of the 2400 pound per acre rate of application over the 1200 pound rate occurred when the potash was derived one-half from KCl and one-half from K_2SO_4 The greatest increase between sources of potash took place when one-half KCl, one-half sulfate of potash-magnesia, was compared with one-half KCl, one-half K_2SO_4. This was true at both the 1200 and 2400 pound per acre rates of application.

The data of table 5 show the significant second order interaction between the factors, rate x placement x source of nitrogen.

When fertilizer was applied one-half broadcast, one-half in bands at the rate of 1200 pounds to the acre, NH_4NO_3 was a better source of nitrogen than Uramon, at the 2400 pound per acre rate, the reverse

TABLE 6—*Effects of treatments on nitrogen content of potato petioles during the growing season and on yields*

Treatment	Date Sampled					Season Average	Least Difference	Yield Bu. U. S. 1 per Acre
	July 13	July 27	Aug 10	Aug. 25	Sept. 8			
			Ppm. N					
Rate of application**								
1200 lbs 5-10-10 per acre	1200	730	530	580	210	650	63	291
2400 lbs. 5-10-10 per acre	1510	890	1030	880	370	936		343
Source of nitrogen								
1/5 N as Uramon, 4/5 as $(NH_4)_2SO_4$	1200	760	720	690	280	730		319
1/5 N as NH_4NO_3, 4/5 as $(NH_4)_2SO_4$	1510	860	850	770	300	858		315
Source of Potash								
All KCl	1320	680	760	660	250	734		307
½ KCl, ½K_2SO_4	1340	900	700	760	290	798		292
½ KCl, ½ Sul-Po-Mag	1380	860	880	780	330	846		353
Placement**								
All in bands	1000	600	520	580	220	584	76	293
½ broadcast, ½ in bands	1760	1040	1090	950	340	1036		335
½ plow sole, ½ in bands	1290	890	740	650	310	776		324
Least difference=251. Ave.	1355	810	780	730	290	793		

**Differences are significant at 1 per cent point

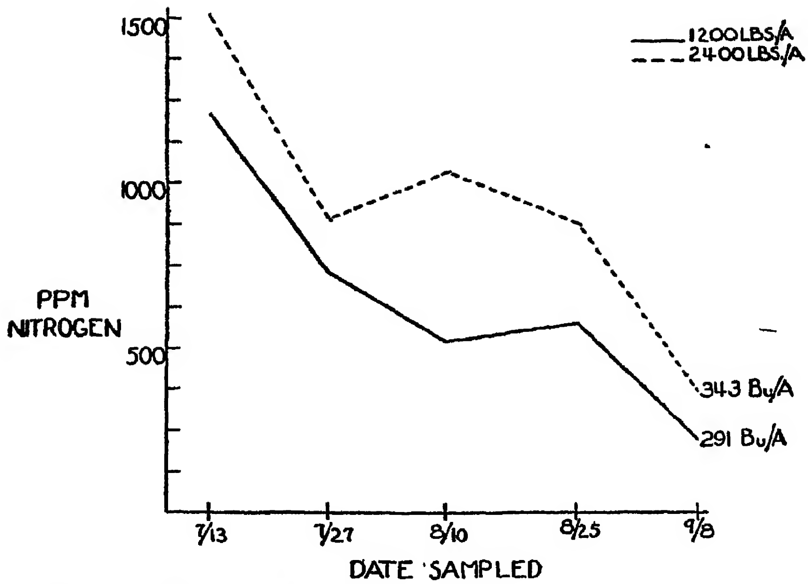

FIGURE 3 Effect of rate of fertilizer application on the nitrogen content of potato petioles during the growing season and their relation to yields of potatoes.

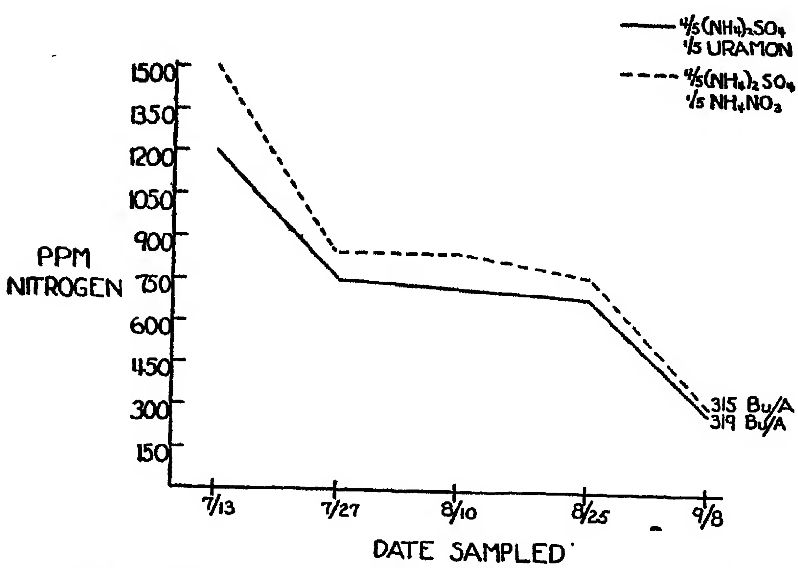

FIGURE 4. Effect of source of nitrogen in the fertilizer on the nitrogen content of potato petioles during the growing season and their relation to yields of potatoes

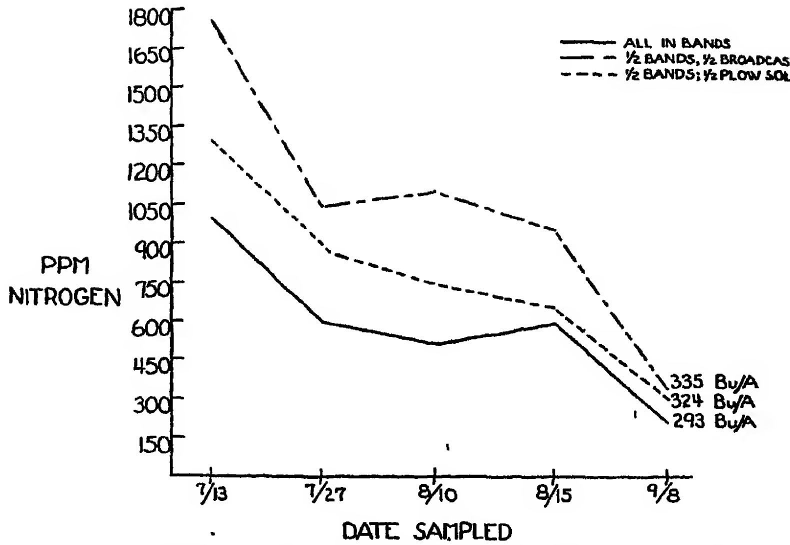

FIGURE 5 Effect of method of placement of fertilizer on the nitrogen content of potato petioles during the growing season and their relation to the yield of potatoes.

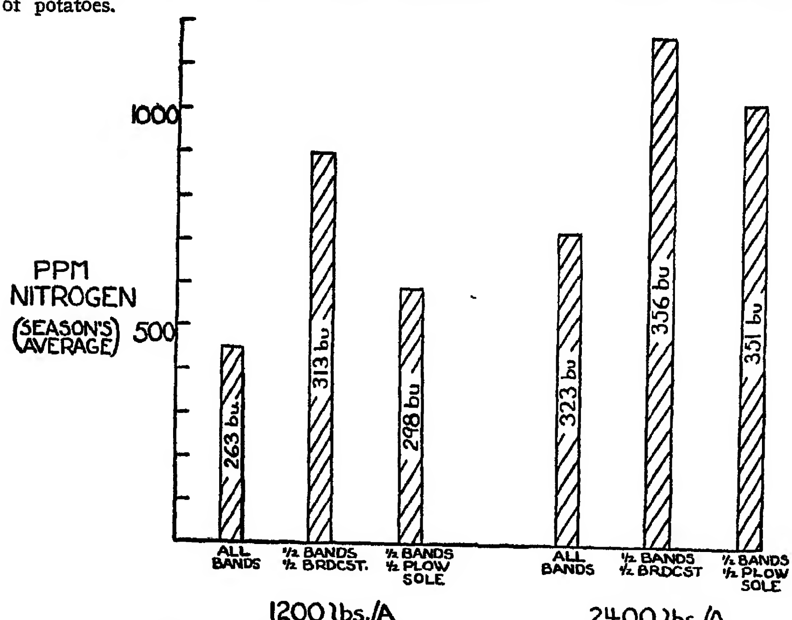

FIGURE 6. Effect of method of placement of fertilizer at two rates of application on the seasonal average nitrogen content of potato petioles and their relation to yields of potatoes. Height of columns denotes amount of nitrogen in the petioles; numbers within the columns denote yields of potatoes.

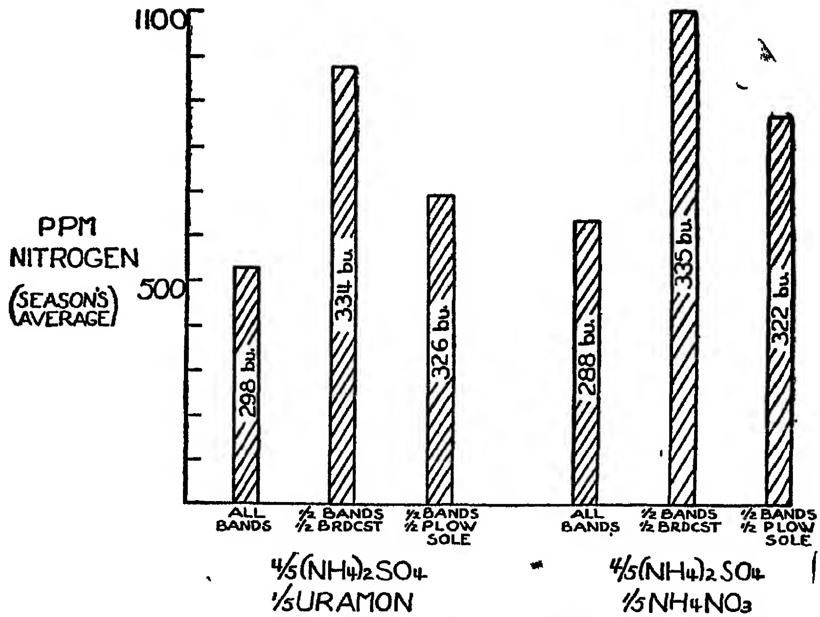

Figure 7. Effect of method of placement of fertilizer and two sources of nitrogen on the seasonal average nitrogen content of potato petioles and their relation to yields of potatoes Height of columns denotes amount of nitrogen in the petioles; numbers within the columns denote yields of potatoes.

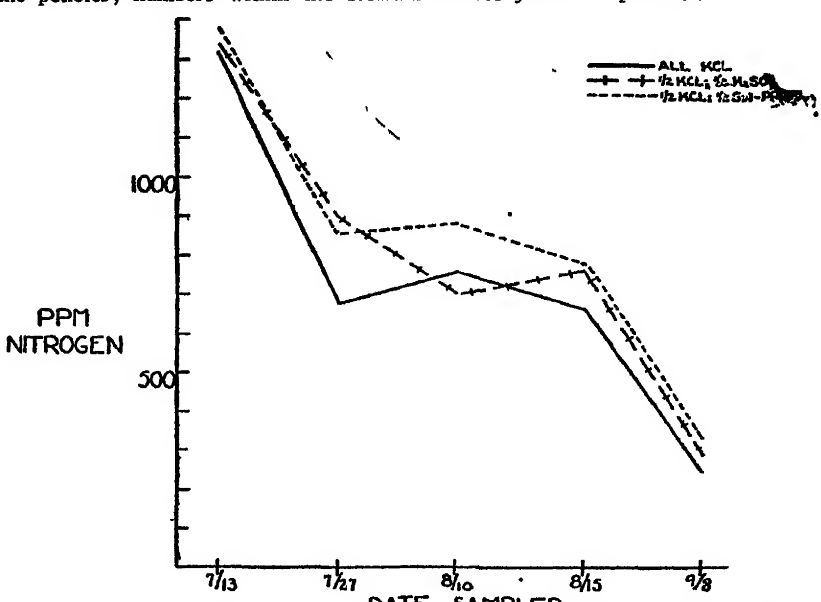

Figure 8. Effect of source of potash on the nitrogen content of potato petioles during the growing season and their relation to yields of potatoes.

TABLE 7—*Effects of treatments on nitrogen content of potato petioles during the growing season and on yields.*

Treatment	Date Sampled					Season Average	Yield Bu U. S 1 per Acre
	July 13	July 27	Aug. 10	Aug. 25	Sept. 8		
1200 lbs. 5-10-10			Ppm N				
All in bands	800	625	333	450	159	473	263
½ broadcast, ½ in bands	1825	1025	733	808	258	930	313
½ on plow sole, ½ in bands	950	708	558	525	233	595	298
2400 lbs 5-10-10							
All in bands	1200	603	725	742	300	714	323
½ broadcast, ½ in bands	1700	1100	1450	1117	425	1158	356
½ on plow sole, ½ in bands	1625	875	942	833	383	932	351

Least differences at 1 per cent point=245 ppm.

was true. When all the fertilizer was applied in bands at the rate of 1200 pounds to the acre, Uramon was a better source of nitrogen than NH_4NO_3; however, at the 2400 pound rate the reverse was true.

Best yields were obtained from 2400 pound per acre applications one-half broadcast, one-half in bands with 20 per cent of the nitrogen in the form of Uramon; lowest yields from the 1200 pound rate when all was applied in bands with 20 per cent of the nitrogen in the form of NH_4NO_3.

Concentration of Nutrients in Potato Petioles

Nitrogen. The concentration of nitrogen in the plants as indicated by analyses of the leaf petioles is shown by the data in tables 6 to 8 and figures 3 to 8.

The correlation of nitrogen content of petioles at each date of sampling with yields of potatoes is highly significant. Undoubtedly, as shown in tables 6 and 7 and figure 3, one of the largest single factors determining increased yields from 2400 pound per acre applications compared with that of the 1200 pound applications was the additional available nitrogen in the fertilizer. The additional phosphorus, potassium, calcium and magnesium in the heavier rate of application probably were not so important in increasing yields since there were no significant correlations between the rates of applications and the concentration of these nutrients in the petioles of the plants.

As shown in tables 6 and 8 and figures 4 and 7, the nitrogen content of peioles grown with applications of Uramon was consistently lower during the season than of those receiving applications of NH_4NO_3. However, these differences were not statistically significant. Also, there was no significant difference in yields of potatoes between the two treatments.

Another important factor in influencing nitrogen content of petioles as well as influencing yields is the method of application of the fertilizer as shown in tables 6, 7 and 8 and figures 5, 6 and 7. Evidently, placement of all the fertilizer bands was not so efficient for its uptake by the plant as either of the other two methods where a portion of the fertilizer is broadcast before plowing or applied on the plow sole.

As shown in tables 6 and 8 and figure 8 there is some indication that source of potash in the fertilizer may influence slightly the uptake of nitrogen by the plants However, these differences were not statistically significant. It is likely that most of the increases in yields obtained from applications of sulfate of potash-magnesia are due to the

TABLE 8—*Effects of treatments on nitrogen content of potato petioles during the growing season and on yields.*

Treatment	Date Sampled					Season Average	Yield Bu U. S. 1 per Acre
	July 13	July 27	Aug. 10	Aug. 25	Sept 8		
All in bands			Ppm. N				
All KCl	820	500	460	540	190	502	275
½ KCl, ½ K_2SO_4	1050	650	500	560	250	602	269
½ KCl, ½ Sul-Po-Mag	1120	650	600	620	230	644	335
½ bands, ½ broadcast							
All KCl	1800	900	1030	820	310	972	331
½ KCl, ½ K_2SO_4	1880	1090	1030	1010	340	1070	305
½ KCl, ½ Sul-Po-Mag	1610	980	1200	1010	370	1034	368
½ bands, ½ plow sole							
All KCl	1320	440	790	620	250	684	316
½ KCl, ½ K_2SO_4	1090	1120	580	650	280	744	302
½ KCl, ½ Sul-Po-Mag	1420	750	860	690	390	822	354
All in bands							
1/5 N as Uramon, 4/5 $(NH_4)_2SO_4$	840	600	480	520	210	530	298
1/5 N as NH_4NO_3, 4/5 $(NH_4)_2SO_4$	1150	600	560	640	230	636	288
½ bands, ½ broadcast							
1/5 N as Uramon, 4/5 $(NH_4)_2SO_4$	1550	1080	990	930	320	974	334
1/5 N as NH_4NO_3, 4/5 $(NH_4)_2SO_4$	1970	1050	1190	980	360	1110	335
½ bands, ½ plow sole							
1/5 N as Uramon, 4/5 $(NH_4)_2SO_4$	1180	660	690	630	310	694	326
1/5 N as NH_4NO_3, 4/5 $(NH_4)_2SO_4$	1600	930	790	690	310	864	322

TABLE 9—*Effects of treatments on potassium content of potato petioles during the growing season and on yields*

Treatment	Date Sampled					Least Difference	Season Average	Yield Bu U S 1 per Acre
	July 13	July 27	Aug. 10	Aug. 25	Sept 8			
Rate of application			Ppm. K					
1200 lbs. 5-10-10 per acre	10010	10780	10930	10000	8200		9980	291
2400 lbs. 5-10-10 per acre	9820	10150	10410	10000	9430		9960	343
Source of nitrogen								
1/5 N as Uramon, 4/5 $(NH_4)_2SO_4$	9980	10410	10930	9460	9260		10008	319
1/5 N as NH_4NO_3, 4/5 $(NH_4)_2SO_4$	9840	10510	10410	10530	8360		9930	315
Source of Potash								
All KCl	10100	10300	11100	10300	9000		10160	307
½ KCl, ½ K_2SO_4	9750	10500	11000	9400	8800		9890	292
½ KCl, ½ Sul-Po-Mag	9850	10600	9900	10200	8700		9850	353
Placement**								
All in bands	9300	10300	9880	9700	8400		9516	293
½ broadcast, ½ in bands	10100	10900	11600	10100	9000	464	10340	335
½ plow sole, ½ in bands	10240	10100	10600	10300	9100		10068	324
Difference required for significance at 1% point = 1055 Average	9880	10433	10693	10033	8833			

**Differences are significant at 1 per cent point.

magnesium content of that potash carrier as shown in table 10, and figures 9 and 10

There were several significant first order interactions among the nitrogen data, namely,—rate of fertilizer application x date of analyses, and method of fertilizer placement x date of analyses. There was also a significant second order interaction of rate of fertilizer application x method of placement x date of analyses.

Phosphorus Evidently sufficient available phosphorus was present in all treatments and in all combinations, for there was no significant difference in concentration of phosphorus in the leaf petioles at any sampling date between the 1200-pound per acre and 2400-pound per acre application nor between any of the combinations of sources of nitrogen or of potash or between the three methods of application of fertilizer.

Potassium. Petioles of plants of all treatments contained large quantities of potassium Evidently sufficient quantities of potassium were taken up by all treatments to result in high yields as shown in table 9. Some other factors were limiting yields in these experiments; probably nitrogen as already shown and magnesium as you will note in tables 10 to 13, and figures 9 and 10 There were significant differences in the concentration of potassium in petioles of plants from plots receiving fertilizer applied in different ways. The largest amount occurred in plants receiving broadcast application of one-half the fertilizer, the smallest where all was placed in bands.

Calcium. Because of the application of lime in the form of Bordeaux mixture as a spray to the leaf surfaces at various times during the season, the analyses for calcium cannot be considered as accurately indicating the concentration of this nutrient in the plants (taken from the fertilizer)

Magnesium The concentration of magnesium in the plants as indicated by analyses of the leaf petioles is shown by the data in tables 10 to 13 and figures 9 and 10

The correlation of magnesium content of petioles with yields of potatoes is highly significant. As shown by the data in tables 10 to 13, and figures 9 and 10, the largest single factor determining yields from different sources of materials was that of sulfate of potash-magnesia. In every case where sulfate of potash-magnesia was contained in the fertilizer, the content of magnesium in the petioles of the plants was highest and the yields also were largest. That the increased yields are due to the magnesium and not to the sulfate form of potash in the sulfate of potash-magnesia was shown by the consistently larger content of

TABLE 10—*Effects of treatments on magnesium contentof potato petioles during the growing season and on yields.*

Treatment	Date Sampled			Season Average	Yield Bu U. S. 1 per Acre
	July 27	Aug. 25	Sept. 8		
	Ppm. Mg				
Rate of application					
1200 lbs 5-10-10 per A	31	36	37	35	291
2400 lbs 5-10-10 per A	33	38	41	37	343
Source of nitrogen					
1/5 N as Uramon, 4/5 $(NH_4)_2SO_4$	30	37	37	35	319
1/5 N as NH_4NO_3, 4/5 $(NH_4)_2SO_4$	34	37	41	37	315
Source of Potash**					
All KCl	26	29	26	27	307
½ KCl, ½ K_2SO_4	25	29	35	30	292
½ KCl, ½ Sul-Po-Mag	45	53	56	51	353
Placement					
All in bands	29	39	39	36	293
½ broadcast, ½ bands	36	36	39	37	335
½ plow sole, ½ bands	33	37	39	36	324

**Differences are significant at 1 per cent point Least difference = 14.

TABLE 11—*Effects of treatments on magnesium content of potato petioles during the growing season and on yields.*

Treatment	Date Sampled			Season Average	Yield U. S. 1 Bu. Acre
	July 27	Aug. 25	Sept 8		
		Ppm Mg			
1200 lbs. 5-10-10					
All KCl	24	28	26	26	286
½ KCl, ½ K_2SO_4	25	31	34	30	260
½ KCl, ½ Sul-Po-Mag	44	52	52	49	329
2400 lbs. 5-10-10					
All KCl	28	31	27	29	329
½ KCl, ½ K_2SO_4	23	28	34	28	323
½ KCl, ½ Sul-Po-Mag	45	55	59	53	376

TABLE 12—*Effects of treatments on magnesium content of potato petioles during the growing season and on yields*

Treatment	Date Sampled			Season Average	Yield U. S. 1 Bu. Acre
	July 27	Aug 25	Sept. 8		
		Ppm Mg			
1/5 N as Uramon					
All KCl	24	28	30	27	310
½ KCl, ½ K_2SO_4	23	30	32	28	298
½ KCl, ½ Sul-Po-Mag	43	54	49	49	349
1/5 N as NH_4NO_3					
All KCl	28	31	23	27	305
½ KCl, ½ K_2SO_4	27	28	39	31	285
½ KCl, ½ Sul-Po-Mag	46	53	62	54	356

TABLE 13—*Effects of treatments on magnesium content of potato petioles during the growing season and on yields.*

Treatment	Date Sampled			Season Average	Yield U. S. 1 Bu. Acre
	July 27	Aug. 25	Sept. 8		
All in bands		Ppm. Mg			
All KCl	25	35	25	28	275
½ KCl, ½ K_2SO_4	21	31	32	28	269
½ KCl, ½ Sul-Po-Mag	40	50	59	50	335
½ bands, ½ broadcast					
All KCl	29	25	27	27	331
½ KCl, ½ K_2SO_4	27	27	37	30	305
½ KCl, ½ Sul-Po-Mag	47	56	54	52	368
½ bands, ½ plow sole					
All KCl	25	27	27	26	316
½ KCl, ½ K_2SO_4	26	29	37	31	302
½ KCl, ½ Sul-Po-Mag	46	54	53	51	354

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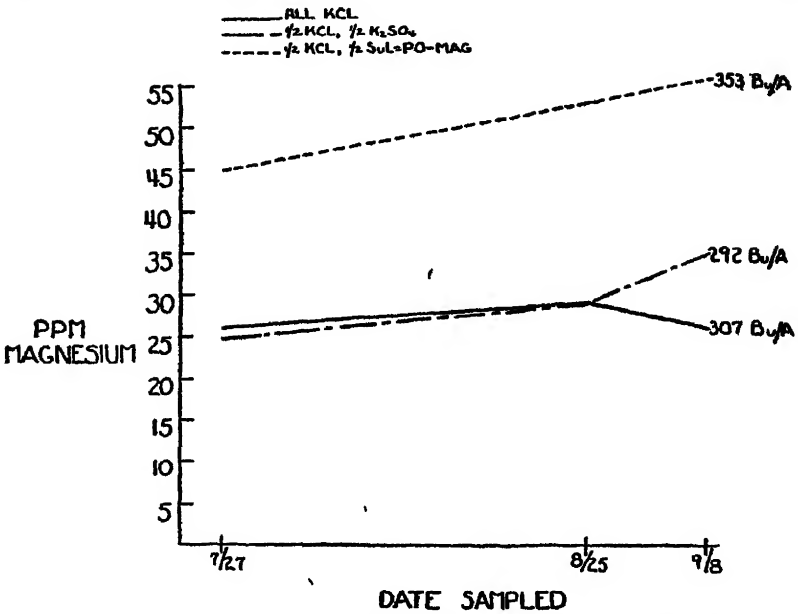

FIGURE 9 Effect of source of potash on the magnesium content of potato petioles during the growing season and their relation to yields of potatoes

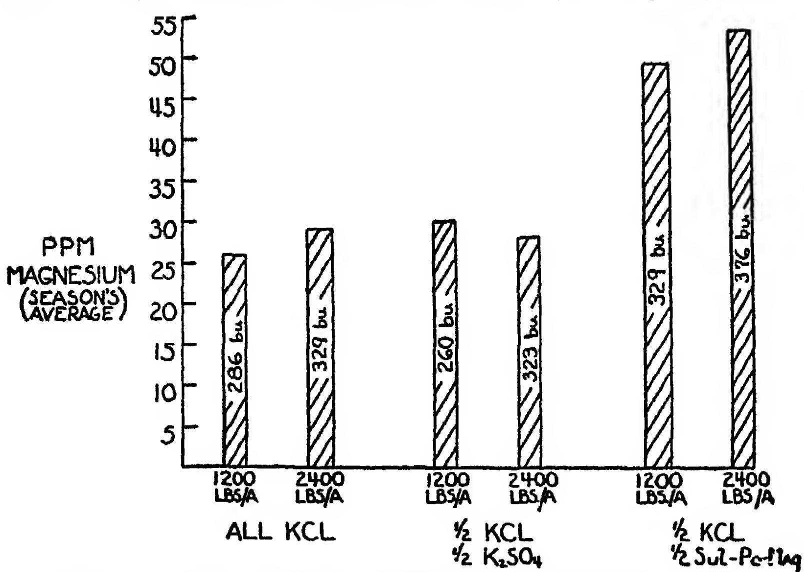

FIGURE 10. Effect of source of potash and rate of fertilizer application on the seasonal average magnesium content of potato petioles and their relation to yields of potatoes. Height of columns denotes amount of magnesium in the petioles; numbers within the columns denote yields of potatoes.

TABLE 14—*Summary table showing main effects of the various individual treatments on specific gravity of the tubers. Each figure is an average of 24 or 36 plots.*

Rate of Application**	Average Specific Gravity of Tubers
1200 lbs. 5-10-10	1 092
2400 lbs 5-10-10	1.087
Placement**	
All in bands	1 092
½ broadcast, ½ in bands	1.088
½ plow sole, ½ in bands	1.089
Source of Potash*	
All muriate	1 088
½ muriate, ½ sulfate	1 091
½ muriate, ½ sulfate of potash-magnesia	1.089
Source of nitrogen	
4/5 amm. sulfate, 1/5 Uramon	1 089
4/5 amm. sulfate, 1/5 amm. nitrate	1 090

*Differences are significant at the 5 per cent point.
**Differences are significant at the 1 per cent point

magnesium in the petioles and the higher yields of potatoes from sulfate of potash-magnesia than from the sulfate of potash.

The data in table 11 and figure 10 indicate that the amount of magnesium contained in the 1200-pound per acre application of 5-10-10 fertilizer with 50 per cent of the potash as sulfate of potash-magnesia was sufficient for optimum absorption of magnesium by the plant and for maximum yields of potatoes under the conditions of this experiment. In this respect magnesium was unlike nitrogen as shown in table 7 and figure 6, where the nitrogen content of the petioles of plants was higher when grown with applications of 2400 pounds than with 1200 pounds of fertilizer to the acre.

No other factor such as rate of application of fertilizer, method of placement or source of nitrogen appeared to have any significant effect on the concentration of magnesium in the plants.

Effects of the Various Treatments on Specific Gravity of the Tubers. The data of tables 14 to 18 show that at rates of application of 1200 pounds of 5-10-10 to the acre the potatoes produced are of significantly higher specific gravity than those produced with 2400 pounds of fertilizer to the acre. This is in accordance with data of other years,

TABLE 15—*Detailed table showing main effects of all treatments on specific gravity of tubers.*

Rate per Acre	Placement	Source of N and K						Average	Average
		1/5 Uramon			1/5 Amm. Nitrate				
		All KCl	½ K_2SO_4	½* $KMgSO_4$	All KCl	½ K_2SO_4	½* $KMgSO_4$		
1200 lbs	All bands	1 092	1 099	1.097	1 093	1 097	1 092	1.095	1 092
	½ broadcast	1.089	1.090	1.091	1 089	1.092	1.090	1.090	
	½ plow sole	1 088	1 095	1.093	1.091	1 096	1.085	1.091	
2400 lbs	All bands	1.085	1.088	1.087	1.090	1.089	1 092	1.088	1 087
	½ broadcast	1.084	1 087	1.084	1.086	1.087	1 087	1 086	
	½ plow sole	1 085	1 087	1 087	1 086	1.087	1.087	1.086	
	Average	1 087	1 091	1.090	1.089	1.091	1.089		
	Average		1 089			1.090			

*Sulfate of potash-magnesia.

TABLE 16—*Effect of rate of fertilizer application and source of potash on specific gravity of tubers as an average of three methods of placement and two sources of nitrogen.*

K Source	Rate		Average
	1200	2400	
All KCl	1.090	1 086	1 088
½ K_2SO_4	1 095	1 087	1.091
½ $KMgSO_4$*	1 091	1.087	1.089
Average	1 092	1 087	

*Sulfate of potash-magnesia

TABLE 17—*Effect of rate of fertilizer application and sources of nitrogen on specific gravity of tubers as an average of three methods of placement and three sources of potash.*

N Source	Rate		Average
	1200	2400	
1/5 Uramon	1 092	1.086	1 089
1/5 NH_4NO_3	1 091	1 088	1.090
Average	1 092	1 087	

where the heavier rates of application have produced tubers with lower specific gravity.

Source of potash also significantly affects the specific gravity of the tubers Where one-half of the potash was from KCl and one-half from K_2SO_4, especially with the 1200 pound per acre rate of application the potatoes were considerably higher in specific gravity than either of the other two sources. At the 2400 pound per acre rate of application there were no large differences between sources of potash.

Method of placement of the fertilizer also had a significant effect on specific gravity of the tubers. At the 1200 pound per acre rate of application the specific gravity of tubers grown with all the fertilizer in bands was higher than the other two methods of placement This was also true, but to a lesser degree, at the 2400 pounds per acre rate of application

There were no significant differences in specific gravity of tubers grown with the two combinations of sources of nitrogen.

There were two significant first-order interactions, namely,—rate of application x source of potash and rate of application x source of nitrogen. The rate of application x source of potash interaction showed that the low application rate and the K_2SO_4 source of K were mutually beneficial to each other in increasing the specific gravity of tubers. In

TABLE 18—*Effect of rate of application of fertilizer, source of nitrogen and source of potash on specific gravity of tubers as an average of three methods of fertilizer placement.*

Rate of Application	Source of Nitrogen	Source of Potash			Average	Average
		All KCl	½ K_2SO_4	½ $KMgSO_4$*		
1200 lbs.	1/5 Uramon	1 090	1 095	1.093	1.093	1.093
	1/5 NH_4NO_3	1.091	1.095	1.089	1 093	
2400 lbs	1/5 Uramon	1 084	1.087	1.086	1 086	1 087
	1/5 NH_4NO_3	1.087	1 088	1 088	1.088	
	Average	1 088	1.091	1 089		

*Sulfate of potash-magnesia.

the rate of application x source of nitrogen interaction, Uramon at the low rate of application increased specific gravity but at the higher rate resulted in a decrease.

There was one significant second order interaction, rate of fertilizer application x source of potash x source of nitrogen. The greatest difference in specific gravity of tubers grown with two different sources of potash existed when Uramon was one of the sources of nitrogen and when rate of application was 1200 pounds of 5-10-10 to the acre. The least difference between these same two sources of potash existed with NH_4NO_3 as one of the sources of nitrogen and the rate of application of fertilizer was 2400 pounds to the acre.

In general, tubers with the highest specific gravity were grown under such conditions that resulted in lowest yields and tubers with the lowest specific gravity were produced by the highest yielding plots.

These data are of value in determining the desirability of the various lots of potatoes for such purposes as table use, starch and alcohol manufacturing and for dehydration and chip making There is a direct and high correlation between specific gravity and mealiness of the tubers, between specific gravity and starch content and between specific gravity and yield of dehydrated potatoes and of potato chips. Highest specific gravity potatoes (1.099) were produced with 1200 pounds per acre of 5-10-10 all applied in bands, with one-half of the potash as KCl, one-half as K_2SO_4 and the nitrogen as 80 per cent $(NH_4)_2SO_4$, 20 per cent Uramon.

Summary and Conclusions

A factorial experiment was conducted during the 1944 season for the purpose of studying the effects of (1) two rates of fertilizer application, (2) three methods of fertilizer placement, (3) three combinations of sources of potash and (4) two combinations of sources of nitrogen on the (a) content of the petioles of the plants of nitrogen, phosphorus, potassium, calcium and magnesium at various times during the growing season, (b) total yield and yield of U. S. No. 1 size tubers and (c) specific gravity of the tubers

Yields of U. S. No. 1 size potatoes resulting from applications of 2400 pounds of 5-10-10 fertilizer to the acre averaged 52 bushels per acre more than with 1200 pound applications Other factors such as source of potash and method of fertilizer placement greatly influenced the yields obtained from any one rate of application.

Yields of potatoes were greatly influenced by method of placement of the fertilizer. Of the three methods employed, that of one-half broad-

cast, then plowed, one-half in equal depth bands at planting time resulted in highest yields The increases in yields of this method of application above that of all in bands at planting time, ranged from 25 to 66 bushels to the acre, depending upon rate of fertilizer application and sources of nitrogen and potash.

The yields of potatoes were further influenced by the source of potash in the fertilizer. Of the three sources of potash used in these experiments, that of one-half KCl, one-half sulfate of potash magnesia, consistently yielded higher than the other two sources. These increases in yield range from 19 bushels to 77 bushels to the acre above that of KCl as the sole source.

Yields of potatoes were not influenced to a statistically significant amount by the sources of nitrogen employed in these experiments when all treatments are averaged.

The correlation of nitrogen content of petioles at each date of sampling with yields of potatoes is highly significant. One of the largest single factors causing increased yields of potatoes from 2400 pound per acre applications compared with the 1200 pound rate was the additional available nitrogen in the larger application

Placement of all the fertilizer in bands at planting time was not so efficient for the uptake of nitrogen by the plant as when a portion of the fertilizer was broadcast before plowing or applied on the plow sole

There was no significant difference in the phosphorus content of leaf petioles at any sampling date between any of the factors studied.

Petioles of plants of all treatments contained large quantities of potassium and evidently sufficient potassium was taken up from all treatments to result in high yields.

The correlation of the magnesium content of petioles with yields of potatoes is highly significant. In every case where sulfate of potash-magnesia was contained in the fertilizer, the content of magnesium in the petioles was highest and the yields were also the largest. That the increased yields were due to the magnesium and not to the sulfate form of potash in the sulfate of potash-magnesia is shown by the consistently larger content of magnesium in the petioles and the higher yields of potatoes from sulfate of potash-magnesia than from the sulfate of potash.

The amount of magnesium in the 1200 pound per acre application of 5-10-10 fertilizer with 50 per cent of the potash as sulfate of potash-magnesia (50.5 lbs MgO per acre) was sufficient for optimum absorption of magnesium by the plant and for maximum yields of potatoes under the conditions of this experiment.

In general, all treatments which tended to increase the yields of po-

tatoes, had a tendency to decrease the specific gravity of the tubers of those treatments. The specific gravity of tubers grown with one-half the potash from KCl and one-half from K_2SO_4 was higher than that of tubers grown with KCl as the sole source of potash.

In general, plants in plots receiving all of the potash in the form of KCl matured and died earlier than did those containing a portion of the K_2O as sulfate of potash-magnesia.

In general, plants in plots receiving all of the fertilizer in bands at planting time matured and died earlier than those in which a portion of the fertilizer was broadcast before plowing or applied on the plow sole.

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SUMMARY OF RESULTS IN SIX STATES WITH DDT AS A POTATO INSECTICIDE IN 1945

DDT the new and much-publicized insecticide won war-time fame as a protector of human health from the scourge of insect-carried disease Almost the entire output of our chemical industry during the war was sent to the armed forces for their needs The small portion left over was used primarily to evaluate its performance as an agricultural insecticide. Now that the war is over the supply of DDT should be plentiful; consequently potato growers are interested in its possibility as a potato insecticide. In order to assemble the results of research on DDT, investigators were invited to submit brief summaries of their work for publication in the AMERICAN POTATO JOURNAL. Investigations from six states are reporting in the following articles Although there is a general agreement on the potentialities of DDT for potato insect control, the place of this new insecticide in the spray and dust program will be secured only after further trial at the hands of investigators and potato growers.

CONNECTICUT*

FLEA BEETLES (*Epitrix cucumeris*) Irish Cobbler potatoes were dusted on the 26th of May, and on the 2nd, 8th and 14th of June, 1944 for control of flea beetles. The damage was estimated on the 5th of June as percentage of the leaves consumed by beetle feeding. No fungicide was applied The yields and damage data are summarized in table 1. The data show the superior control obtained by DDT The two higher concentrations of DDT also produced high yields.

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TABLE 1—*Control of flea beetles with DDT, derris and cryalite dusts.*

Material	Concentration	Per cent Beetle Damage	Yield-Grams Per Plant
DDT Dust	4 per cent	9 0	351
	2 " "	9 3	337
	1 " "	11.3	273
	5 " "	11 5	261
Derris Dust	2 " " (rotenone)	11 3	288
	1 " "	12 5	301
	.5 " "	14.0	251
	.25 " "	13 8	274
Cryolite Dust	50 " "	11 8	308
	25 " "	11 8	255
	12½ " "	13 5	244
	6¼ " "	11.8	341
No treatment	.. " "	19 0	269

POTATO LEAFHOPPER (*Empoasca fabae*). Green Mountain potatoes were dusted on the 6th, 18th, and 25th of July and on the 1st of August, 15th and 22nd, 1944 compared with bordeaux mixture applied on the same dates. Tipburn was estimated on the 13th of August and the data are summarized in table 2.

TABLE 2—*A comparison of leafhopper control and yields from the use of DDT dust and bordeaux mixture.*

Material	Concentration	Per cent Reduction Leafhoppers - Aug 2	Per cent Tipburn Aug 13	Yield Gms Plant
DDT dust	4 per cent	81 5	59.1	331
	2 per cent	76.3	79 2	248
	1 per cent	60 5	74.3	277
	.5 per cent	84.2	83.6	189
Bordeaux Mixture	4-2-50	38 5	73 8	275
	2-1-50	5 8	81.5	253
	1-.5-50	0	83.7	255
	.5-.25-50	0	90.6	178
No treatment		..	90.5	247

DDT provided superior control of leafhoppers and tipburn and resulted in yields at least as high as bordeaux mixture produced.

Growers added DDT spray powder to both bordeaux mixture and *Dithane* in large-scale single-block tests. The spray provided exception-

ally good control of flea beetles. Leafhoppers were not a serious pest in 1945. Where flea beetles were abundant, DDT produced a higher yield than the fungicide alone. In the most outstanding case the use of one-half pound of actual DDT in a spray powder in ten bordeaux mixture sprays increased the yield 24 per cent above bordeaux alone. Flea beetles were the serious pest.

The application of one pound of DDT per acre in a kerosene-xylene mixture by means of a Coast Guard helicopter provided excellent control of flea beetles and leafhoppers, but the effect was transitory. Migration and emergence of flea beetles re-populated the fields within a week

NEBRASKA*

DDT was first tested for controlling potato insects in Nebraska during the 1944 season and the results for that year have been summarized in Research Bulletin 138 of the Nebraska Agricultural Experiment Station, entitled "Effects of DDT and Other Insecticides on Several Species of Potato Insects" Further tests involving this material were undertaken in 1945 in the commercial potato growing sections of both central and western Nebraska.

Tuber Flea Beetle Control. A field experiment designed to compare the effectiveness of three dusts containing 2 5 per cent DDT (a, mechanically mixed with 300 mesh sulfur; b, mechanically mixed with pyrophyllite; and c, fused with sulfur) and the standard cryolite-sulfur dust (1-3 by weight) was conducted at the Scottsbluff Experiment Station near Mitchell. All dust mixtures were applied with power dusters at the rate of approximately 35 pounds per acre four times during the season. The flea beetle infestation was light and the results obtained with the four dusts were not significantly different. However, all were effective and statistically superior to the untreated checks.

In another test a dust containing 3 per cent DDT in pyrophyllite and one containing 1 per cent DDT fused with sulfur gave similar degrees of control when measured by sweeping the plots 24 hours following application. However, the DDT-sulfur dust remained more effective over a period of several days and continued to kill many newly developed beetles as they emerged from the soil. A dust containing 1 per cent DDT in pyrophyllite gave unsatisfactory control.

In a third test at the Scottsbluff Experiment Station DDT-pyrophyllite dust mixtures were applied by hand below the surface of the soil and one to two inches above the seed piece at the time of planting.

*Roscoe E Hill, Nebraska Agricultural Experiment Station, Lincoln, Nebr.

Dusts of 3, 6 and 10 per cent DDT were used at the uniform rate of 300 pounds of the mixed dust per acre so that the amount of DDT actually applied was 9, 18 and 30 pounds per acre. All three treatments significantly reduced the amount of larval damage to the tubers. Potatoes from plots receiving 30 pounds of DDT to the acre were of slightly better quality than those harvested from plots where 9 pounds had been used. However, the degree of freedom from flea beetle damage was so low in all plots that the results cannot be considered conclusive. The data indicate that different DDT formulations and/or better methods of application might produce results of value. No evidence of injury to potato plants was observed

Aphid Control. Sweep-net records showed aphid counts to range from 9 to 47 in plots treated with 2 5 per cent DDT dust as compared with 126 where the standard cryolite-sulfur dust was used and 186 in the untreated checks. This evidence of control along with similar data obtained in 1944 is important to potato growers who are interested in the production of seed potatoes. It indicates that this new material may be used without building up the aphid population as is generally the case in Nebraska following the use of zinc arsenite. In fact, the evidence suggests that DDT has definite aphicidal properties when used against *Myzus persicae* on potatoes.

Large Field Tests with DDT. Four neighboring commercial potato growers near Scotsbluff cooperated in a large scale test with DDT. All potato fields on the four farms were treated from four to five times with a 3 per cent DDT-pyrophyllite dust. Insect collections were made at regular intervals throughout the summer in each of the treated fields and also from nearby plantings on surrounding farms which had been treated with the standard cryolite-sulfur dust. The DDT treated fields were noticeably "free" from insects General observations also were made on the insect populations of adjoining crops, alfalfa, sugar beets, corn and garden crops, in order to determine if outbreaks or increases of other species occurred as a result of the destruction of predatory and parasitic insects. Insofar as could be determined no increases of harmful insects occurred. Although some beneficial species were killed in treated fields this did not appear to have any appreciable effect on the insect problem as a whole.

In addition to the above intensive experimental area, DDT was distributed to other growers by local insecticide dealers and used in large scale field tests and demonstrations under the general supervision of the Department of Entomology From these tests it was demonstrated that DDT may be used effectively and safely by commercial

potato growers for combatting injurious potato insects under Nebraska conditions.

Use of Airplanes for Applying DDT Dusts. Airplanes were first used in 1945 for the application of insecticides to Nebraska potato fields. At the Scottsbluff Substation a preliminary test was conducted for the purpose of comparing the effectiveness of DDT dusts applied by airplane and ground machinery. The plane used was a Navy N-3-N trainer. Both methods of application resulted in excellent kill of tuber flea beetles as measured by sweep-net collections 24 to 30 hours after dusting. However, dusts applied with ground machinery gave somewhat better control of secondary pests such as the false flea hopper[1] and two species of leafhoppers[2]

Observations in several commercial fields which had been dusted with the above-mentioned plane also revealed that this method of applying a 3 per cent DDT dust gave good results against the tuber flea beetle. Because of the general and extremely low potato psyllid[3] infestation it was impossible to obtain information regarding the effectiveness of dust applied by airplane for controlling this insect

Central Nebraska Plot Test. The cool wet season resulted in an exceptionally low insect population in the experimental plots near Kearney. Consequently the results obtained were greatly restricted. However, the best control of the Colorado potato beetle, potato leafhopper and *Lygus* bugs was given by the dusts and sprays containing DDT.

NEW JERSEY*

The Departments of Plant Pathology and Entomology cooperated in conducting one dust and one spray experiment with DDT on the Katahdin variety of potatoes in 1945.

Ten treatments were employed in the spray experiment including some in which 2 pounds of 50 per cent DDT Powder† were added to an 8-8-100 Bordeaux and to a 4-100 Microgel (tribasic copper). These combinations were compared with Bordeaux alone and Microgel alone, respectively. Sprays were applied on the 9th, 15th, and 25th of June and on the 9th and 25th of July with an eight-row power sprayer, using 100 to 125 gallons per acre at 300 pounds pressure Due to excessive

[1]*Chlamydatus associatus* (Uhl)

[2]*Aceratagallia uhleri* (Van D.) and *Empoasca fabae* (Harris)

[3]*Paratrioza cockerelli* (Sulc.)

†50 per cent Tech. DDT — 50 per cent clay, pulverized, furnished by Sherwin-Williams Co. This product was used in all DDT treatments

*John C. Campbell and Bailey B. Pepper, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

rainfall during July, the sprays could not be applied at weekly or 10-day intervals throughout the test as planned.

Insect collections were taken on the 15th and 20th of June and on the 3d, 10th and 31st of July. Fifty net sweeps were made in each treatment at every collection. The number of insects secured from the first four collections was averaged and the largest average number obtained per sweep from any treatment was as follows: leafhoppers, 32.8; flea beetles, 3.4; and aphids, 2.2 per sweep. At the last collection, which was made following an interval of 16 days between sprays, the largest average number of insects secured per sweep on any treatment was leafhoopers, 33.9; flea beetles, 9.8; and aphids, 1.0. From these figures it can be readily seen that the insect population was never great enough to be an important factor with respect to yields and the DDT had little opportunity to demonstrate its ability to control them. A severe outbreak of late blight developed between the 20th and 25th of July and although no fungicidal properties are claimed for DDT, there were decidedly fewer blighted leaves in the plots sprayed with DDT than in plots not receiving DDT. This may possibly be explained by the fact that there were fewer insects on these plots to disseminate the organism from plant to plant.

Yield data were taken from six 1/90th-acre plots in each treatment. The average total yield obtained from the plots sprayed with Bordeaux was 420.1 bushels per acre, whereas the average yield of the plots sprayed with Bordeaux plus 2 pounds of 50 per cent DDT was 506.1 bushels,—an increase of 86 bushels per acre. The plots sprayed with Microgel yielded 457.4 bushels per acre whereas those sprayed with Microgel plus DDT produced 491.6,—an increase of 34 bushels per acre. These yield increases are rather outstanding, in view of the relatively high yields produced by the controls and the few insects present throughout the season.

In the dust experiment all dusts were applied with a 6-row power duster using 30 to 35 pounds of dust per acre. The applications were made on the 8th and 15th of June and the 2d, 10th and 27th of July. Two treatments were included in which 3 per cent DDT dusts were used. These treatments were 30-6-64 Copper-DDT-lime dust and 21-6-73 Microgel-DDT-talc dust. A 30-70 Copper-lime and a 21-79 Microgel talc dust were used as controls. Insect collections were made as in the spray test on the 15th and 20th of June and the 3d, 10th and 31st of July. Here again the insect population was very small and there was little opportunity for DDT to be a major factor in increasing yields through insect control. The greatest number of leafhoppers and flea

beetles was present at the last collection when the average number per sweep reached 24 9, and 8.4, respectively. The aphid population was highest early in the season but never averaged more than 4 per sweep. Although there were fewer leafhoppers on plots dusted with Microgel and DDT, the reduction was not great enough to be of consequence

Yield data were taken from six 1/60th-acre plots. The average yield produced by plots dusted with 30-70 copper-lime was 327.0 bushels per acre and plots dusted with 30-6-64 copper-DDT-lime yielded 333 2 bushels. Plots receiving 21-79 Microgel-talc produced 345 1 bushels per acre and those dusted with 21-6-73 Microgel-DDT-talc produced 383.4 bushels,—an increase of 38 bushels per acre in favor of DDT It is difficult to explain the difference in results from the two treatments,—a yield increase from the DDT-Microgel, and none from DDT-copper-lime dust. However, DDT may not be completely compatible with lime.

Summary

Two pounds of a 50 per cent water-dispensable DDT, when added to 100 gallons of Bordeaux or Microgel spray and applied to Katahdin potatoes, resulted in yield increases of 86 and 34 bushels per acre respectively, despite the fact that few insects were presnt at any time. The use of a 3 per cent DDT-copper-lime dust gave no insect control or yield increase, whereas a 3 per cent DDT-Microgel-talc dust slightly reduced leafhoppers and increased the yield by 38 bushels per acre

NEW YORK*

Experiences with DDT have been so generally satisfactory that this new insecticide seems likely to become an integral part of the spray and dust program. It has proven thus far to give effective control of the major foliage feeding insects and remains active over longer periods of time than some of its predecessors: nicotine, pyrethrum, rotenone and the thiocyanates.

The Colorado potato beetle, (*Leptinotarsa decemlineata*) a pest in some areas, succumbs to relatively light applications of DDT. A dosage as low as one-half pound of DDT per acre in either spray powder or dust form compared favorably with the recommended strengths of calcium arsenate and rotenone.

The potato flea beetle (*Epitrix cucumeris*) and the leafhopper *Empoasca fabae,* are common to all potato producing sections of the state.

*W. A Rawlins, Cornell University, Ithaca, N Y.

Formerly considerable attention was given to promoting rotenone-pyrethrum combinations for reducing severe infestations. Bordeaux mixture particularly with a high lime content provided considerable protection if used regularly and thoroughly. The advent of DDT seems certain to change there previous recommendations radically DDT has been found far superior to pyrethrum and rotenone insecticides due principally to its better residual effectiveness. When added to bordeaux there is no advantage in using more than a minimum amount of hydrated lime DDT is considerably more effective in protecting potatoes from insect damage than heavy bordeaux residues.

Dosages of one to one and one-half pounds of DDT per acre for each application in a regular schedule is suggested when using spray powder or dust formulations The emulsifiable solutions have given equally good kills in amounts as low as one quarter of the above concentrations but the residual toxicity is not quite so good

The success of DDT against the two aphid species, *Macrosiphum solanifolii* and *Myzus persicae* is of considerable interest to New York potato growers. Aphids are an annual problem on Long Island and occasionally up-state. To many growers DDT offers some possibility of alleviating virus spread by preventing large build-up of aphid populations. Its potentialities in this respect remain to be investigated

In all experimental tests of the past two seasons DDT has been very satisfactory in comparison with other insecticides for aphid control The quantity needed in sprays and dusts to keep aphids adequately in check is somewhat higher than the dosages for other potato pests. Under field conditions experimental results show that increments of DDT up to 2.25 pounds per acre gave progressively increased control of aphids and larger yields In emulsifiable solutions one quarter of the above quantity will give comparable results.

Tarnished plant bugs (*Lygus pratensis*) are as susceptible to DDT as the potato leafhopper according to limited data obtained in last season's experiments. Plant bug infestations are not widespread but at times are severe enough to cause considerable concern to potato growers. Control with the quantities of DDT suggested for flea beetles and leafhoppers is adequate.

One of the outstanding attributes of DDT has been its residual toxicity or ability to prevent build-up of insect populations for days after application. Insecticides such as rotenone, pyrethrum and nicotine are excellent toxicants but relief is temporary and populations quickly build up again. Therefore, any insecticide possessing a long-lasting effect would be an improvement compared with these standard materials

The residual effectiveness of DDT varied with different species of potato insects. Leafhoppers and plant bugs were kept in check for long periods of time. However, flea beetles during the summer emergence period shunned the sprayed foliage and collected in large numbers on the new growth. Unless this new growth was promptly sprayed they were able to cause considerable damage. The aphid, *Macrosiphum solanifolii* also tended to multiply rapidly between applications *Myzus persicae* was much easier to keep under control as populations increased slowly after DDT treatment.

It is evident from experience to date that for best results potato foliage should be thoroughly covered with DDT during the insect infestation period. In New York State this means the addition of the insecticide to each fungicide application from the time of appearance of Colorado Potato Beetle slugs until insect populations decline near the end of the growing season. A total of four to eight applications will be needed in the control program according to the region and the maturity date of the variety.

DDT is compatible with the fungicides commonly used for disease control with the exception of copper lime dust. Opinion is consistent that lime in dry form will react unfavorably with DDT. As far as insect control is concerned differences between bordeaux, neutral coppers and the newer organic materials were small and inconsequential. The quantity of DDT needed to give effective control may vary with different fungicides but data are too meager to warrant further comment.

The value of sprays and dusts in terms of increased production is of major interest to the potato grower. Increases in yield from DDT treatment left little doubt as to its effectiveness as a potato insecticide. Data from numerous field plot comparisons located in several producing sections of the state have been summarized in table 1 on page 144. These results were obtained from supplementing the fungicide with DDT as all plots were treated alike for disease control Although the yield increases cannot be considered as representative of what may be expected in the future, returns have been satisfactory enough to insure DDT a place in the potato pest control program.

OHIO*

DDT in 1944 and 1945 gave the most outstanding performance of any material that has been recorded for use on potatoes during the past 25 years. This insecticide, used alone and in combination with various fungicides, gave phenomenal control of the potato leafhopper (*Empoasca fabae* Harris), exceptional control of the potato flea beetle (*Epitrix cu-*

*J. P. Sleesman and J. D. Wilson, Ohio Agricultural Experiment Station, Wooster, Ohio.

TABLE 1—*Yield increases from the addition of DDT to fungicide sprays and dusts for control of potato insects.*

County	Number Applications	Concentration per 100 Units Spray or Dust	Yield Increase
Suffolk	5 spray	2# DDT	110.4
Suffolk	3 dust	5% DDT	99 3
Suffolk	4 spray	2# DDT	82 8
Suffolk	5 spray	2# DDT	77.1
Suffolk	2 spray	2# DDT	95 3
Suffolk	4 dust	2% DDT	58.5
Suffolk	4 spray	2# DDT	77.1
Monroe	4 spray	1# DDT	135 5
Monroe	9 spray	1# DDT (BL-DDT)[1]	67.7
Monroe	4 spray	2# DDT	130 8
Monroe	3 spray	1 qt 20% DDT[2]	67.7
Monroe	6 spray	1# DDT	122 0
Monroe	5 spray	1# DDT	100.7
Monroe	3 spray	1# DDT	67.2
Monroe	5 spray	1 qt. JP70[3]	72 3
Monroe	3 spray	1# DDT	55.0
Wayne	3 dust	3% DDT	30 8
Erie	3 spray	1# DDT	57
Erie	3 spray	1# DDT	47
Erie	3 spray	1# DDT	42
Erie	2 spray	1# DDT	20

[1]Contains nicotine
[2]Gesarol emulsion (Geigy Co.)
[3]Residue from DDT refinement (J. Powell Co) contained 11 per cent DDT.

cumeris Harris), good control of the green peach aphid (*Myzus persicae* Sulzer), and significantly higher yields than those obtained with any other treatment.

In 1945 detailed investigations were conducted in three widely separated potato-growing areas of the state on Irish Cobbler and Sebago varieties of potato. The materials were applied at 10-day intervals at the rate of 200 gallons of spray material per acre. Each treatment was replicated four times in randomized blocks. Although more than 50 different spray and dust formulas were tested in these experiments, only those that produced results of particular interest are discussed in this paper. Wettable DDT powder was used at the rate of three-quarters pound of the active ingredient in each 100 gallons of spray material

The data presented in table 1 give the degree of foliage protection,

leafhopper populations, number of adult flea beetle feeding punctures, aphid populations, and yields obtained from eight different treatments in four separate experiments. The data obtained from these experiments show: that DDT, used in combination with various fungicides, gave a 51 per cent larger yield (an average increase of 141 bushels per acre) than was obtained with calcium arsenate when used with the same fungicides; that Zerlate gave a higher yield than that obtained with bordeaux mixture, COC-S, Fermate, or Dithane when each was used with either calcium arsenate or DDT; that Zerlate gave good control of early blight (*Alternaria*) but that it was inferior to bordeaux in the control of late blight (*Phytophthora*); that DDT completely eliminated the potato leafhopper as a factor in reducing yields; that DDT gave better control of the potato flea beetle than was obtained with calcium arsenate; that DDT applied at 10-day intervals throughout the growing season gave good control of aphids; and that the addition of calcium arsenate to fungicides was associated in some manner with a rapid build-up in aphid populations.

Data obtained in these experiments but which are not presented in this summary show: that DDT dust gave results comparable to those obtained with DDT spray when equal amounts of actual DDT were applied by the two methods; that under Ohio conditions DDT should be applied in combination with a good fungicide; that DDT samples obtained from three different manufacturers in the form of wettable powders gave similar results; that DDT solubilized in miscible oils gave results comparable to those obtained with wettable powders; and that the application of 1 pound of actual DDT (2 pounds of 50 per cent DDT composition) per acre per application gave results comparable to those obtained when larger amounts of actual DDT were used.

In 1945 twelve grower tests were conducted in widely separated sections throughout the state under the direction of Professor E. B. Tussing. The plots ranged from one-third acre to 4 acres each in size and involved Cobbler, Katahdin, Russet, Erie and Sebago varieties Plots dusted wih a fixed copper—talc mixture produced an average yield of 250 bushels per acre, whereas plots dusted with a fungicide plus DDT (3 per cent active ingredient) produced 344 bushels per acre. The data recorded from plots sprayed with bordeaux mixture plus calcium arsenate showed an average yield of 277 bushels per acre. In comparison the average yield from plots treated with bordeaux plus DDT (1 pound of 50 per cent wettable powder in 100 gallons) was 344 bushels per acre. Since the spray materials were applied at the rate

TABLE 1—*Foliage condition, aphid populations, leafhopper populations, number of adult flea beetle feeding punctures, and yield for the treatments shown, based on the means of four replications, four separate experiments, Wooster, McGuffey, and Marietta,* 1945.

	Foliage Score Per cent Alive	Aphids per Leaf No.	Leafhopper Nymphs per 100 Leaves No.	Flea Beetle Puncture per Leaflet No.	Yield Bushels per Acre
Zerlate + calcium arsenate, 2-4-100	57	565	111	10	290
Bordeaux + calcium arsenate, 8-8-4-100	58	498	60	11	280
COC-S + DDT, 4½-4-100	53	411	53	9	277
Fermate + calcium arsenate, 2-4-100	49	500	431	10	255
Zerlate + DDT, 2-3-100	74	12	0	5	445
Bordeaux + DDT, 8-8-3-100	71	10	0	6	405
COCS + DDT, 4½-3-œ100	68	7	0	7	394
Fermate + DDT, 2-3-100	69	9	0	6	422
Fungicides + calcium arsenate (means)	54	494	164	10	276
Fungicides + DDT	71	10	0	6	417
No treatment	46	26	661	35	265

TABLE 1.—*Gain in yields from DDT applications with bordeaux spray in 1945*

No. Tests	Variety	No DDT Applications	Yield from Bordeaux Alone Bu /Acre	Gain in Yield from DDT Applications Bu /Acre	Per cent Gain
1	Bliss Triumph	4	232	23	10
15	Katahdin	1-10	290.9	71.1	24
2	Cobblers	2-5	327.5	77.5	24
3	White Rural	5-6	283	73.5	26
4	Russet Rural	1-12	276.5	100.5	36
1	Menominee	4	232	18	8
4	Sebago	2-10	246	67	27

TABLE 2.—*Gains in yield from varying the number of DDT spray applications.*

Variety	No Tests	No. Applications of DDT	Gain in Yield from DDT Bu /Acre
Katahdin	3	1 to 3	66
	7	4 to 5	54
	4	6 to 7	92
	1	10	129
Sebago	1	2	10
	1	4	54
	1	7	41
	1	10	163
Russet Rural	1	1	46
	1	4	115
	1	6	73
	1	12	168

of 125 gallons per acre it is probable that insufficient actual DDT was used to secure maximum yield.

To secure the maximum benefit from DDT in the spray program, growers should apply, at ten-day intervals, one pound of actual DDT per acre, at each application in approximately two hundred gallons of spray mixture. If the amount of spray applied is less than the optimum amount of 200 gallon per acre, the concentration should be increased to provide one pound of actual DDT per acre at each application.

PENNSYLVANIA*

In order to check on the effectiveness of DDT for controlling potato foliage insects, a total of 33 demonstrations was conducted with the co-operation of potato growers in 17 counties of the state during 1945 In all fields the DDT bordeaux plots adjoined those given a similar bordeaux mixture treatment. Each set of comparative plots was located in an area of the field where the soil was of the same type and fertility level.

DDT was used as a spray at the rate of approximately one pound of actual DDT to an 8-4-100 bordeaux. Although wettable DDT

*J O Pepper, Extension Entomologist Pennsylvania State College, State College, Pa.

TABLE 3.—*Comparison of yields from use of DDT fixed copper dust and monohydrated copper-arsenate-lime dust, 1945*

No. Tests	Variety	No. DDT Applications	Yields Bus Acre		Gain in Yields from Use of DDT	Per cent Gain
			DDT-Fixed Copper	Copper-Lime-Arsenate		
2	Katahdin	4-6	297	180 5	116 5	65
1	Sequoia	4	122	77	45	58

powder was used in most demonstrations, liquid DDT emulsion was tested in some. The bordeaux mixture was prepared in the spray tank and the DDT added last The amount of spray used varied from 100 to 150 gallons per acre per application. A summary of these spray demonstrations showing the increase in yields due to the use of DDT is given in table 1.

In has been stated by some entomologists that the gain in yields from the use of DDT is proportional to the number of applications used In general our demonstrations confirmed this observation up to the maximum of 10 or 12 applications. The summary of these figures is given in table 2

Three demonstrations using DDT as a dust were conducted on potatoes. The dust contained 3 per cent DDT combined with the fixed copper (5 per cent metallic copper) as the fungicide The diluent was pyrophyllite. This dust was compared with the standard potato dust composed of monohydrated copper, calcium arsenate, and lime Approximately 35 pounds of dust were applied per acre per application employing a good dusting machine. The results of these dust demonstrations are indicated in table 3 which shows the increase in yields caused by improved insect control from use of DDT. It is apparent from these observations, notably increased yields, that DDT has given excellent control of our potato foliage insects during 1945

SECTIONAL NOTES

ALABAMA

Unusually good weather during late January and early February permitted the planting of our crop within a short period. Warm weather during February and March has advanced the crop Our stands are good, and the tubers are forming Plans are now being made for handling the crop

Some new equipment is being installed and our old equipment is being repaired

Growers are looking with much hope to the Sebago

Blight is showing up this year somewhat earlier than normal As a result a considerable number of growers are following a regular dust schedule; others are spraying with dithane

With favorable weather a good crop is expected; adverse weather could result in considerable loss from late blight (March 30—L. M WARE AND FRANK GARRETT

CALIFORNIA

The potato acreage in the floor of the valley, exclusive of those that will be planted in the mountains at a later date, now stands at an estimated total of 61,000 acres

From all general appearances the crop will probably give an excellent stand. There are no particular disease problems at present that are expected to affect the yield Fertilizers have been short but apparently the growers have been able to secure enough nitrogen to produce a good crop

Cold weather retarded the sprouting of the approximate 12,000 acres in the early section at Arvin and Edison and this will probably mean a bigger peak shipment this year than in previous years. Our peak shipment will probably come the last week in May or the first week in June (Mar. 27)—M A. LINDSAY.

FLORIDA

The potato acreage in the Hastings section is about 13,000 acres Ninety-five per cent of the area is planted to Sebago and the other 5 per cent to Katahdin, Pontiac, Bliss and Sequoia.

There have been no freezes to injure the crop and rainfall has been sufficient to promote rapid growth of the plants Late blight is present in the early-planted fields but it has caused no serious injury as yet Dithane is being used to control blight in fields totaling about 500 acres. Digging will not begin until the 8th of April or later (March 15)—A. H EDDINS

IDAHO

Certified seed potatoes are moving out very rapidly and it appears that all of the record crop will be cleaned up without much difficulty Reports from northern Idaho show that practically all certified seed are contracted This is partly because of the increased use of certified seed by commercial growers and partly due to the fact that a great deal of the seed stock has been sorted and the large tubers over eight ounces sold for commercials The extent of this is shown by the fact that the Ashton territory, which is largely a seed area, has already shipped more than eighty cars of table stock. The demand for early varieties exceeds the supply and these varieties are selling at ceiling. Certified Netted Gems have increased in price during the past few weeks and are now selling near the ceiling price.

The growers indicated intentions to plant as of January were about 15 per cent less than last year, but recent increases in prices of table

stock will undoubtedly influence these intentions and if prices continue strong the reduction under last year's record plantings may be considerably less (Mar. 21)—JOHN R. ROBERTSON.

IDAHO

Potato shipments continue to be heavier than they were a year ago The total shipments to date exceed those of last year by 4,000 cars. Prices have dropped ten per cent from the high of $3.00 per hundred, f.o.b cars, that was offered early in March This drop was no doubt due, in part, to the threat that ceiling prices would be put in force if potato prices got out of line Quite a few potatoes are used by the dehydrators which undoubtedly helped steady the market Most of the stock remaining is in the dealers' hands. A good percentage of the crop is moving in consumer-sized packages The best stock is being held back for later shipments.

The seed situation remains the same. There seems to be ample seed stock for commercial plantings. It is difficult to predict planting for 1946, although the recent improvement in the market seems to have a bullish effect on intentions to plant Nevertheless, there seems to be little doubt that there will be a reduction in acreage compared with last year The latest report by the Bureau of Agricultural Economics, Division of Agricultural Statistics, indicates that Idaho will plant 172,000 acres which is 17 per cent under 1945

The fertilizer situation remains tight; not enough to meet the demand. This is true for the nitrogen-phosphate fertilizers for potatoes and the straight phosphate material for the legume crops. Legume crops receive most of the phosphate fertilizers; succeeding crops in the rotation benefit greatly from these applications. Commercial fertilizers are rarely used on potatoes the first year following the legume crop. (Apr 2)—J. L TOEVS.

INDIANA

The early-maturing potatoes have been planted in our state—the weather being ideal for this operation. There was sufficient moisture in the ground, and it was also dry enough on top to do the planting, since we are enjoying mid-May weather at the present time.

The growers of the late crop are getting their ground in readiness for planting and I presume there will be a large acreage planted by the end of the month

There is quite a flurry for certified seed,—particularly for some of the newer varieties which have performed so wonderfully in Indiana in the past two or three years.

The fertilizer situation is unchanged. Every one wants fertilizer and it is rather difficult to convince our people that there is much congestion as well as confusion in getting the fertilizer when you want it. I don't know why they will not buy fertilizer during the off-season and the same is true with potato varieties.

The acreage in Indiana will be normal again this year.

Many of our fruit trees are in bloom and it is the first time that I can remember seeing so many peaches in full bloom during the month of March. If the fruit crop goes this year, you know what it is going to mean to our consumers—that is, a good old vegetable diet. (Apr. 1.) —W. B. WARD.

MISSISSIPPI

Most of our farmers have received sufficient fertilizer for potatoes. Therefore, the acreage is about the same as last year. Planting was delayed about ten days because of excessive rainfall at planting time. The last few weeks of good weather, however, have stimulated those sections.

The best estimate I can give is that we still expect to ship the latter part of May or the first of June. The largest shipping area will be at Columbus, Mississippi, where they have planted about 1,800 acres. (Apr. 3.)—J. E. SNOWDEN.

SOUTH DAKOTA

The ideal weather for the past two weeks has caused the ground to become so dry that growers have started to prepare their ground for the potato crop. Plenty of good local seed is available this year. Almost 2,000 acres of the 7,250 that passed for certification were listed as foundation seed having less than ½ of 1 per cent virus with many fields showing only a tract.

At the annual meeting of the South Dakota Potato Growers' Association held on the 30th of March, growers expressed their intention of planting about the same acreage as last year at which time 8,800 acres were entered for certification. Charles A. Larkin of Clark is now president of the Association, succeeding E. A. Fletcher of Garden City, who retired after 6 years of service. There will be a shortage of fertilizer in this area since very little fertilizer has been used in the past and there is no established quota for the potato section. Tests with fertilizer have taught growers that an increase in yield can be secured.

All the growers in this area disinfect their seed,—some using hot formaldehyde, some, the acid-mercury treatments; and others, Semesan Bel. Practically all the cutting of seed is done by hand. The potato area

in South Dakota is concentrated in four counties in the northeastern section of the state,—with smaller acreages in the adjoining counties In this section the soil is a sandy loam and the altitude ranges from 1750 to 2000 feet (Apr 5)—JOHN NOONAN.

TEXAS

Late blight is at present very erratic in its appearance in the Los Fresnos area in Cameron County In some fields east of Los Fresno, including the field of Kenneth Schuchman, in which it first appeared in that section, much damage has been done, and the yields will definitely be greatly reduced Heavy applications of copper dusts upon and immediately surrounding the spot of first appearance apparently stopped its progress there to a great extent However, it appeared later in surrounding fields, where even greater damage has been done. The earliest planting of potatoes in that area is damaged less than some of the younger plantings Much of the damage in young plantings is due to stem infection, killing the entire portion of the stem above Sometimes only a single infected leaf was responsible for the stem infection In the area west of Los Fresnos, in general, relatively little damage has been done so far by blight. Heavy applications of various copper dusts (whatever is available) are being continued, even though failures to get good results in the eastern Los Fresnos area has discouraged many growers The first appearances of blight have almost invariably been in North Dakota seed fields, which, in general, are earlier than Nebraska seed fields (Mar 26)—G H GODFREY

OREGON

Present indications are that the potato acreage will be slightly less than the all time high acreage, planted last year. However, with the approach of planting season and the demand for food by the U S D A Famine Committee, present ideas of acreage might be increased The fertilizer situation is tight comparable to the situation prevailing a year ago The shipments of both seed and table stock from this area are nearly completed. Despite the increased acreage last year shipments will be considerably less The demand for White Rose seed has been excellent, but the demand for certified Russets seems to be much less than it was a month ago (Mar 27)—C A. HENDERSON

JOINT MEETING OF THE POTATO ASSOCIATION OF AMERICA AND THE INTERNATIONAL CROP IMPROVEMENT ASSOCIATION

NOTES ON BACTERIAL RING ROT

J. W. SCONNELL

The Canadian Provinces of Nova Scotia and British Columbia are free of bacterial ring rot as far as is known In Prince Edward Island there was only one case found in a small field of table stock in 1945 Some infected fields have been found in the other Provinces, but in most places this disease is on the decrease, especially in the Province of Ontario, where a rigid inspection of both seed and table stock fields is carried out Canadian certified seed of all classes has a zero tolerance for this disease.

The State of Maine reports several seedlings that show resistance to ring rot, but stressed the value of tuber indexing in order to keep the stock free Although this disease is widespread, it would appear from the discussions at Chicago that a concerted effort is being made to control it in most places Wyoming reports a new resistant seedling which they have named Teton.

Sanitation measures were recommended as a means of control, with special reference to the use of new containers

LEAFROLL AND NET NECROSIS

C. D. GAINES

The leafroll disease of potato has been known for a great many years in certain sections of the United States At the present time, the more serious problems concerning leafroll seem to be located largely on the Pacific and Atlantic Coasts Some inland states, particularly near the Great Lakes, are also familiar with the disease and are concerned with the control. Within recent years in Washington, Oregon and California, as well as Maine, New York and some of the other Eastern States, losses have occurred to a greater or less extent, depending upon the locality.

It is understood that the Green Mountain variety in the state of Maine, which used to be the standard variety, is now largely passing out of the picture because of the leafroll disease and incident net necrosis in the tubers Likewise, the Netted Gem variety or Russet Burbank, in the state of Washington, was formerly used on about 95 per cent of the total potato acreage At the present time, this variety is passing

out of production because of leafroll and incident net necrosis in the tubers.

The discussion at the International Crop Improvement Association meeting in Chicago last December indicated a few items that, if put into practice, would at least aid in the control of the leafroll disease One of these is the early killing of the plant in order to prevent late current season infection. Another suggestion was late planting which also aids in the prevention of spread These two methods of prevention are apparently associated with insect population during the early and late season plantings Because of the late planting and early killing of the vines and consequently lower yields, this would not be practical if applied on large commercial plantings. However, by using the practice in small stock seed lots or seed plots, it was felt that it would materially aid in controlling the leafroll disease

The use of DDT as an insect control is somewhat hopeful, judging from the results secured. Some rather outstanding results have been reported as the result of one or two years' experience It is generally felt that we lack complete information and consequently cannot recommend the use of DDT except from the various tests reported However, this material seems very hopeful. If the various diseases, which are carried by insects, particularly some of the species of aphids, can be controlled by killing the insects, this would certainly be a valuable asset in seed potato growing

There was also a small discussion about some of the new varieties that are more or less resistant to the leafroll disease So far as the Pacific Coast is concerned, however, there are no varieties in sight that would entirely replace the Netted Gems.

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SEED AND SOIL TREATMENT FOR THE CONTROL OF POTATO SCAB

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INTRODUCTION

Common scab of potatoes caused by the fungus *Actinomyces scabies* (Thaxt) (Guss) has become more serious as a market factor since more emphasis has been placed on quality by an increasingly discriminating public Scab causes an otherwise acceptable product to be placed in the unprofitable or marginal class of farm products.

No particular potato growing area of the United States produces scabby potatoes as a whole but certain fields or parts of fields consistently produce scabby tubers In the Greeley, Colorado area, some fields that have produced scab-free tubers in the past, are now producing a high percentage of scabby tubers In some instances a single hill of tubers will be found to be heavily scabbed, whereas those in the adjoining hills will be free from scab Growers pay very little attention to such light or scattered infections but when such tubers are marketed the loss shows up in the reduced number of No 1 or salable tubers

Many attempts have been made to control common scab Seed and soil treatments have been devised and to date none has been satisfac-

[1]Pathologist

tory Many conflicting reports on the value of seed and soil treatments for scab control have been made in the literature Cairns, *et al* (1) working in Ireland found that satisfactory control of scab was obtained by the disinfection of the affected seed tubers before planting, provided a sufficient interval had elapesd between the growing of successive potato crops in the same land A great many factors are involved and man's ability to change the chemical and physical relationships encountered in soils, seems limited. A great deal has been published on the chemical and physical factors that affect scab development Two variables, the organism and the environment, must be considered. It is generally accepted that when the soil reaction is lowered below pH 5 2, scab infection is greatly reduced (7) Some physiologic races of *A scabies* are quite tolerant of acid soils (8) and there is little doubt that races of the organism exist that are capable of causing infection over a wide range of pH It is extremely difficult to change the chemical and physical environment in a given soil and such a change may affect only a few races of *A scabies* present.

The mercury salts have been found to be effective in killing the scab organism on the seed piece but they have been used with doubtful success for killing the fungus in the soil. Martin (5) reported a reduction in the amount of scab on tubers grown in soils treated with calomel, yellow oxide of mercury, or Semesan applied with fertilizer at planting time In 1931 MacLeod and Hurst (3) found that seed treatment can be depended upon only as giving partial control of scab in Prince Edward Island, and in 1943 MacLeod and Howatt (4) reported that good control of scab was obtained by the use of mercuric chloride and calomel applied to the soil at the rate of 10 to 15 pounds per acre. Apparently these results were obtained in soils that were slightly acid Taylor (9) found that the addition of mercury to the limestone soils of New York served to increase scab infection When large quantities of mercury are added to the soil there may be danger of killing beneficial organisms and the cost of the treatment would be prohibitive.

Since the scab organism lives and increases in the soil independent of the potato, seed treatment could not be expected to prevent infection It is possible that new physiologic races might be introduced into a given soil *via* the infected seed piece but the chances of survival and rapid increase of a new race is not likely. Many cases of scabby seed producing a clean crop and of clean seed, a scabby crop, have been observed Attempts to inoculate normally scab-free soils by adding large quantities of scabby tubers were made by the writer and no increase

in scab infection was obtained The reason for this failure to inoculate soils in this way is not fully understood.

With the above factors in mind it is quite easy to come to the conclusion that any attempts to control common scab by seed or soil treatment in certain parts of the country are doomed to failure, or at least to meet with little success. In part this has been true. The following experimental results indicate that such is the case, but it must be kept in mind that these experiments were conducted in soils that were alkaline and highly buffered. It is not meant to imply that all attempts at control of scab by chemical and cultural means should be abandoned On the contrary, the efforts to find a specific chemical treatment or treatments that will kill the scab organism on the seed piece and in the soil, even temporarily, should be continued. Cultural practices may greatly influence the increase of the scab organism in the soil and may also influence the development of the antagonistic relationships between *A scabies* and other soil-borne organisms The work of Goss (2) and Millard and Taylor (6) indicates that the parasitism of the scab organism is affected by these factors.

Results of Experiments on the Control of Scab

The following experiments were conducted in scabby soil located in the early potato growing area of northern Colorado. The soil was a fine sandy loam with a pH of 7 6 and was irrigated. The variety Bliss Triumph was used since it is commonly grown in this area and is very susceptible to many races of *A. scabies* The test plots were grown in areas of the fields that had produced several severely scabbed crops of potatoes

Table 1 shows the results of applying mercuric chloride and yellow oxide of mercury, 6 pounds per acre, to the soil in the opened row, previous to planting, scab-free seed Clean seed was treated with mercuric chloride 1-1000, for 1½ hrs Untreated clean seed was planted as a check Scab-infected seed, treated and untreated, were also included in the plot. The chemicals were mixed with fine dry sand and applied uniformly by hand in the opened row Thorough mixing was accomplished by raking the chemical bearing sand into the soil The seed pieces were dropped and covered by hand to a depth of 5 to 6 inches. The treated and untreated seed were also dropped in the open furrow and covered to the same depth Subsequent culture of all lots was uniform.

The results of the tests are given in table 1 and show that treatment of the soil with 6 pounds of mercuric chloride or yellow oxide of mercury, did not reduce the number of scab-infected tubers over the un-

TABLE I—*Effect of treating scab infested soil with mercuric chloride and yellow oxide of mercury, 6 lbs. per acre and treatment of scab infected and clean seed with mercuric chloride on the control of scab on Bliss Triumph potatoes in Colorado.*

Type of Seed	Treatment	Amount and Method of Application	Per cent of Scabby Tubers[1]	Per cent of Area Scabbed[2]
Scab-free	Mercuric chloride	6 lbs per acre, mixed with sand. Applied to soil in furrow	95.4[3]	60[4]
Scab-free	Yellow oxide of mercury	" "	93.0	63
Scab-free	Mercuric chloride 1-1000	Clean seed soaked in $HgCl_2$ 1½ hrs. Soil not treated	93 0	65
Scab-infected	"	Infected seed soaked in $HgCl_2$, 1½ hrs. Soil not treated	90.0	65
Scab-infected	None	No treatment of seed or soil.	95.2	60
Scab-free	None	" "	94.2	60

[1]Mean of all tubers produced in five, 25 hill replications
[2]Mean of a random sample of 100 tubers from each of five, 25 hill replications.
[3]Difference required for significance at the 1 per cent level=4 04.
[4]Difference required for significance at the 1 per cent level=7 11

treated check. A significant decrease in the number of scabby tubers was noted when scab-infected seed was treated with mercuric chloride, 1-1000, 1½ hrs, but there was not a corresponding decrease in the area scabbed. There is no accurate method for determining area scabbed and the data in table 1 was obtained by estimating the amount of area covered

None of the treatments of soil or seed reduced scab infection in amounts sufficient to be of commercial importance.

A second soil treatment plot was located in a field which had produced heavily scabbed tubers for four years. The pH of this soil was 7 8 and was a fine sandy loam. The five chemicals used and the amount applied per acre was as follows: mercuric chloride, 6 lbs.; sulfamic acid, 50 lbs.; sulphur, 500 lbs.; aluminum sulphate, 10 lbs, and potassium iodide, 10 lbs. Clean untreated seed was planted by hand in the open furrow and covered to a depth of 5 inches.

Sulfamic acid is a new sulphur compound soluble in water to the extent of 21.3 per cent. It was hoped that this soluble sulphur would temporarily acidify the soil in the immediate vicinity of the growing tubers and prevent the infection and subsequent development of scab.

At harvest time each hill was dug by hand and the tubers carefully examined. The tubers from all treatments were as heavily scabbed as the check No control was effected by the use of the above chemicals in the amounts used. These data showed no significant differences between the treatments for the amount of tubers infected or the area scabbed. (Table 2.)

The reports in the literature regarding the value of sulphur for the control of common potato scab have been conflicting and appear to be most successful when used in soils that are normally below pH 6.0 Muncie *et al* (7) found that sulphur, when added to the soil with acid fertilizer in Michigan, reduced scab infection. The soil in these tests was found to vary between pH 4.5 and 6 0. When sulphur is added to a soil bordering on acidity, a reduction in pH might be expected, but when added to a soil with a pH of 7.5 to 9 0, as is commonly found in western potato growing areas, little effect on pH is noted. The pH of most western soils varies between 7 0 and 9.0 and are highly buffered with calcium, magnesium and in some cases with sodium salts. To change the soil reaction in these highly alkaline soils would require large quantities of acid fertilizer and sulphur. In most cases the amount required would be entirely impractical when considered from a commercial point of view Muncie *et al* (7) found that the greatest amount of scab reduction occurred in plots receiving 3200 pounds of sulphur

TABLE 2—*Results of treating scab infested soil with chemicals on scab infection of Bliss Triumph potatoes.*

Treatment	Pustule Type	Per cent of Scabby Tubers[1]	Per cent of Area Scabbed[1]
Mercuric Chloride 6 lbs. per acre.	4[2]	80 0[3]	40 0[4]
Sulfamic acid 50 lbs. per acre	4	77.0	38.0
Sulphur 500 lbs. per acre.	4	80 2	38.0
Aluminum sulphate 10 lbs. per acre	4	81 6	40 0
Potassium iodide 10 lbs per acre.	4	78 2	40.0
None. Check	4	80.0	40 0

[1]Mean of five 25-hill replications.
[2]Pit type scab pustules.
[3]Difference required for significance between means at 1 per cent level 23 89.
[4]Difference required for significance between means at 1 per cent level 8 64.

per acre with acid fertilizer and that in these treatments a great deal of damage to the plants resulted.

Aluminum sulphate and potassium iodide did not reduce the number of tubers infected or the amount of area scabbed In this test mercuric chloride did not reduce scab infection.

Profitable potato growing necessitates not only a reduction in the area scabbed but also in the number of infected tubers. A reduction of 30 or 40 per cent in number of infected tubers should not be considered efficient control in most cases The need of a chemical, specific for the control of soil-borne scab is great and the search for new chemicals to effect this end should be intensified.

EXPERIMENT WITH SULPHUR AND SULFAMIC ACID

A test in which 500 and 1,000 pounds of sulphur per acre were applied to a soil heavily infested with scab, showed no reduction in scab infection Three types of application were used (1) Sulphur was spread on the barnyard manure in the manure spreader and this was distributed over the plot and plowed under immediately Scab-free seed was planted 3 weeks later (2) Sulphur was applied to the soil by means of the fertilizer attachment on a potato planter, as bands to the

side and below the seed pieces (3) Sulphur was applied in the furrow by hand and mixed, previous to dropping of scab-free seed.

At harvest time the Bliss Triumph tubers were severely scabbed in both the treated plots and the checks. Potatoes were planted in these same plots the following two years but no reduction in scab infection was noted

Sulfamic acid (HSO_3NH_2), is a solid, crystalline, inorganic acid. It is soluble in water to the extent of 21.3 per cent at 20° C. and solutions of the acid are highly ionized, giving pH values in the same range as hydrochloric and sulphuric acids

Experiments with sulfamic acid were conducted in the greenhouse and in the field. Dilutions as low as 1-10,000 were found to be toxic to growing potato plants when applied to the soil around the roots. In the field it was applied to the soil at planting time at the rate of 50 and 100 lbs. per acre, mixing the powdered sulfamic acid with the soil surrounding the seed pieces, and on the surface of the moist soil around the plants when they were approximately 10 inches high pH readings were made on the soil 3 inches below the surface before the sulfamic acid was applied in the soil and on the surface and again 3 weeks after application. The original pH was 7.3 and after 3 weeks it was 7.0 This variation might well be accounted for on the basis of error in the pH readings All plots receiving the above treatments with sulfamic acid produced scabby tubers No appreciable reduction in scab infection on the treated lots over the checks was noted All lots were heavily scabbed and no detailed data were taken. Apparently large quantities of this material would be required to overcome the buffer action in the soil before temporary acidity could be effected. It is possible that this water soluble compound might serve to reduce scab infection

Summary

Treatment of seed and soil with certain chemicals was found to have no value in controlling scab infection in the irrigated, sandy soils of northern Colorado The soils in which these tests were conducted, produced several crops of heavily scabbed tubers previous to these tests.

Treatment of these scabby soils with mercuric chloride, yellow oxide of mercury, sulfamic acid, aluminum sulphate, potassium iodide and sulphur, did not reduce scab infection

Treatment of scab-infected seed with mercuric chloride reduced the number of infected tubers over the infected untreated seed.

When sulphur was added with manure to the scabby soil, three weeks previous to planting and to the opened row at planting time, scab

infection for the current season or the two following seasons, was not reduced

None of the seed or soil treatments appear to have value for the control of scab in the alkaline soils of northern Colorado. Clean treated seed produced scabby tubers in the scab-infested soil.

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SOME LABORATORY AND FIELD DATA ON RING-ROT OF POTATOES IN CALIFORNIA

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Ring-rot of potatoes is still a serious bacterial disease of potatoes In California the disease was reported in 1939 (1). Since the fundamentals of the disease have been worked out (14) and the information pertaining to handling the crop to avoid serious losses has become available to the growers, the disease may be considered, at the present time, under practical control Yet the disease may strike at any time in all its destructiveness, so characteristic of the trouble, as soon as the vigilance on the part of the seed grower and precautionary measures on the part of commercial growers are neglected,—even for a short time

Solution of the ring-rot problem depends on production of disease-free seed by seed growers. As long as seed is produced which is infected

with ring-rot and sold to commercial potato growers, they will of necessity have to use every sanitary precaution to reduce the spread of the disease in the seed after it is purchased. There are four "danger zones," as far as the ring-rot disease is concerned, through which seed pieces pass before planting, namely 1) spread of the infection by the cutting knife; 2) infection that may occur on the cutting table; 3) contamination by contact in the sack and planter hoppers; and 4) infection spread by the spikes in a picker planter.

Since clean, disease-free potato seed is the responsibility of the seed growers, it is important that they should adopt the best known methods of recognizing the disease before planting their known potato stocks.

To aid the growers and the certification inspectors, a Committee on Standardization of techniques for diagnosing ring-rot was appointed in 1939, that Committee issued a circular of approved methods of diagnosing ring rot (5).

The writer desires to present certain portions of the data accumulated during an intensive study of the ring-rot disease in 1939-'40 and to point out certain findings resulting from the field observations and greenhouse experiments dealing with ring-rot.

Ooze Test to Diagnose Ring-rot—In the course of investigations on ring-rot of potatoes, beginning in 1939, there were evolved in a number of states definite methods of diagnosing the disease before the seed is planted and later in the plants in the field. Thus, Gram staining of bacteria, present in both the stem and the tuber, was suggested by Racicot and Savile in 1938 (13) In 1940, Iverson and Kelly (6) developed a method of diagnosing the disease in the tubers by ultraviolet light. This latter method is found to be very useful in diagnosing the earliest phases of the disease In many laboratories it has been found very helpful as a presumptive test and, when followed by Gram staining, gave very good results Recent findings of Skaptason (14) on the nature of the fluorescence (riboflavin) due to ultraviolet lamp does not minimize the value and importance of the test.

In California, a very simple and highly accurate method is used in the preliminary diagnosis of bacterial diseases of plants This consists in microscopic examination of diseased tissues for the presence of bacterial masses when a slice of infected tissue is placed in a drop of sterile water, on a slide, and examined under the low power objective without a cover slip This method of observing the bacterial extrusion, a phenomenon undoubtedly due to osmosis, has frequently been employed by phytopathologists since the discovery that bacteria cause plant diseases Examination of Stewart's (19) or Smith's (16) writings will

convince one of the early recognition and practicability of the method. A very good picture of the ooze (bacterial extrusion) is given in Stewart's paper on bacterial wilt of corn (19). As applied to ring-rot, the method consists in shaving off a small slice of suspected tissue, either with a razor or a thin-bladed scalpel, placing it in a drop of sterile water, making a sharp cut through the middle of the piece and examining the mount without a cover glass under the low objective of a compound microscope It is desirable to cut down on the intensity of light in order to observe quickly the mass of bacteria moving out the tissues as an extrusion After long standing the bacteria disperse in the water and cannot be distinguished without the aid of an oil-immersion objective With a little practice, this operation can be performed very rapidly. Examination with a high-dry objective or with an oil-immersion lens, when a cover slip is placed on the mount, can supply the information on motility of the organism As is well known, *Phytomonas sepedonica* is non-motile and the cells have a very characteristic appearance (4, 13) Of course, this procedure will not be applicable where there is no macroscopic indication of the presence of the disease. This test, however, is of value where there is doubt as to the bacterial nature of the symptoms The test is suggested as a short cut to ascertain the nature of the trouble, preliminary to other confirming tests such as Gram staining and inoculation of plants The presence of bacteria packed between the cells of turgid tuber parenchyma tissue is practically presumptive for ring-rot, since in the two other parenchyma diseases of bacterial origin, blackleg and soft rot, the tissue is softened and there is a bad odor, and the disease, caused by *P. solanacearum* is primarily vascular.

Incubation Tests—Where ring-rot is known to have been present in the seed stock and it is desired to clean up the stock in the shortest possible time, incubation tests, in addition to the ooze test and Gram staining, can be resorted to This consists in cutting short pieces off the stem end of a potato, placing them in clean, moist peat-moss and incubating at 28°C for about three weeks. At the end of this time the potatoes which contained the ring-rot pathogen will show symptoms of the disease in various degrees This procedure helps in the detection and elimination of diseased potatoes in a given lot, or in a family, leaving only the clean ones for propagation The practicability of the method can be judged from the fact that one commercial grower of seed potatoes cleaned his entire stock in two seasons by this method

Disinfection Studies—The infectiousness of the ring-rot disease is well known to all who have worked with it (14, 15, 18). Since the

spread of the disease is to a large extent by mechanical means (on tools and equipment) the question of disinfection of contaminated surfaces is of paramount importance. Different common disinfectants were tested in 1940-1941 (14). It was found that the cutting knife when dipped momentarily in the following solutions, after the cut was made through a diseased tuber and the seed piece cut with a disinfected knife was planted in soil, gave the following percentage of ring-rot, as compared with 35 9 per cent disease in the check plot in which dipping into disinfectant was omitted. Mercuric chloride, 1 500 in 70 per cent Ethyl alcohol—14 6 per cent; Mercuric chloride, 1 1000 in 70 per cent Ethyl alcohol—1 2 per cent; 1 per cent Mettalic iodine, + 2 per cent Potassium iodide + 10 per cent glycerin—2 4 per cent; Chlorax 50 per cent —6 2 per cent; Calcium hypochloride, 1 ·1000—60 per cent; and Lysol, 2 per cent—29 3 per cent In disinfecting the knife contaminated with the ring-rot bacteria the difficulty arises from bacterial slime so abundantly present in diseased potato. It was shown in a previous publication (2) that the knife should be wiped on a cloth prior to dipping in order to insure the removal of the slime and tissue debris that might otherwise protect the bacteria from actual contact with the disinfectant

That bacterial slime exerts a pronounced effect on the efficiency of disinfectants can be seen from table 1. The results shown in table 1 were obtained by using a) pure cultures of *Phytomonas sepedonica* in broth, b) bacterial slime (mixed with broth) obtained from ring-rot potatoes where there was no complication by secondary organisms, and c) a mixture of the pure cultures of *Phytomonas sepedonica* (in broth) and the sterilized bacterial slime from diseased potato (this being mixed with water before sterilization). The turbidity of the culture was adjusted to #6 of the MacFarland's nephelometer (9) Equal parts of the suspension and the disinfectant were put together for a specified time after which two loopfuls of the mixture were transferred to nutrient broth adjusted to pH 6 9. The tubes were incubated at 28°C and were not discarded for thirty days

Dreft (sodium laurel sulfanate) which is toxic to pure cultures of *Phytomonas sepedonica* in nutrient broth in a concentration of ½ per cent is rendered ineffective in the presence of the untreated slime even in a concentration of 2½ per cent Sterilization of the slime seems to destroy its protective properties against the disinfectants Thymol in combination with copper sulphate acquires germicidal properties against *Phytomonas sepedonica* utterly lacking when either material is used alone. Neither thymol nor copper sulphate in a concentration of 1 to 2000 show bactericidal properties against *Phytomonas sepedonica* How-

TABLE 1. *The effect of bacterial slime on the efficiency of bacterial poisons.*

Disinfectant	Concentration	Time of Exposure, Min	*Phytomonas sepedonica.* Pure Culture in Nutrient Broth			*Phytomonas sepedonica* As Slime from a Ring-rot Potato			*Phytomonas sepedonica* As Pure Culture in the Sterilized Slime		
			Turbidity after Days								
			6	10	14	6	10	14	6	10	14
Mercuric chloride	1 1000	2	—*	—	—	—	—	—	—	—	—
		5	—	—	—	—	—	—	—	—	—
"	1 2000	2	—	—	—	+*	+	+	—	+	+
		5	—	—	—	+	+	+	—	—	+
Dreft	½%	2	—	—	—	+	+	+	—	—	—
		5	—	—	—	+	+	+	—	—	—
		10	—	—	—	+	+	+	—	—	—
"	1%	2	—	—	—	+	+	+	—	—	—
		5	—	—	—	+	+	+	—	—	—
		10	—	—	—	+	+	+	—	—	—
"	2½%	2	—	—	—	+	+	+	—	—	—
		5	—	—	—	+	+	+	—	—	—
		10	—	—	—	—	—	—	—	—	—
"	5%	2	—	—	—	—	—	—	—	—	—
		5	—	—	—	—	—	—	—	—	—
		10	—	—	—	—	—	—	—	—	—
Thymol	1:2000	2	+	+	+	+	+	+	+	+	+
		5	+	+	+	+	+	+	+	+	+
"	1:4000	2	+	+	+	+	+	+	+	+	+
		5	+	+	+	+	+	+	+	+	+

TABLE I. *The effect of bacterial slime on the efficiency of bacterial poisons (continued).*

Disinfectant	Concentration	Time of Exposure, Min	*Phytomonas sepedonica* Pure Culture in Nutrient Broth			*Phytomonas sepedonica* As Slime from a Ring-rot Potato			*Phytomonas sepedonica* As Pure Culture in the Sterilized Slime		
			Turbidity after Days								
			6	10	14	6	10	14	6	10	14
Thymol + $CuSO_4$	1:7000	2	—	—	—	—	—	—	—	—	—
Copper sulphate	1:2000	5	—	—	—	—	—	—	—	—	—
Copper sulphate	1:2000	2	+	+	+	+	+	+	+	+	+
		5	+	+	+	+	+	+	+	+	+
Gentian violet	1:2000	2	—	—	—	+	+	+	—	—	—
		5	—	—	—	—	—	—	—	—	—
"	1:4000	2	—	—	—	+	+	+	—	—	—
		5	—	—	—	+	+	+	—	—	—
Thymol + Gentian violet	1:2000	2	—	—	—	—	—	—	—	—	—
	1:4000	5	—	—	—	—	—	—	—	—	—
Malachite green	1:2000	2	—	—	—	—	—	—	—	—	—
		5	—	—	—	—	—	—	—	—	—
	1:4000	2	—	—	—	+	+	+	—	—	—
		5	—	—	—	+	+	+	—	—	—
Malachite green + Thymol	1:4000	2	—	—	—	—	—	—	—	—	—
	1:2000	5	—	—	—	—	—	—	—	—	—

* Minus sign signifies the absence of growth
Plus sign signifies growth.

ever, when the two materials in the same concentration are combined they are capable of killing bacteria even in the slime. The same synergistic action of the thymol was observed when it was added to a very weak concentration of iodine.

Soft Rot Phase in Ring-rot—Before the true nature of the disease, as it occurred in Kern County, was determined, the general complaint was that potatoes got soft and foul-smelling. Soon it became clear that in its early stages the disease now known to be ring-rot has no soft rot phase but a very light creamy discoloration in and near the turgid tissues of the vascular ring of the stem end. As soon as the diseased tissues become mealy, cracks of various sizes appear near the apical end of the potato and secondary organisms gain entrance From then on the amount of the soft rot in a field increases The softness of infected tubers increases with the increased activity of various saprophytic bacteria which follow *Phytomonas sepedonica.* An opinion was expressed in 1939 (3) that ring-rot could be a precursor of bacterial soft rot which has caused the estimated loss of 500 to 700 cars of early potatoes from 28,000 acres in one county alone, in 1939. Racicot, Savile and Connors (13) also referred to soft rot complications when *Phytomonas sepedonica* infects the potato. Kreutzer and McLean (10) presented some experimental evidence on enhancing soft rot in ring-rot potatoes when they were inoculated on the surface with a drop of the bacterial suspension of *Erwinia carotovora* According to the writers (10) "the indications were that slices from tubers affected with *Phytomonas sepedonica* showed a greater degree of rotting than those which were free from infection by *Phytomonas sepedonica.*"

Soon after reporting on the occurrence of the disease in California, in 1939 (3), the writer performed a series of experiments on severity of the soft rot of potatoes, with and without ring-rot bacteria, by inoculating with *Erwinia carotovora* (from carrot roots) and the blackleg organism, *Erwinia phytophthora* (from potatoes) Medium-sized potatoes were selected for the experiment and only those with a trace of ring-rot were chosen for inoculation purposes Examination for the presence of the disease was made by cutting a small-sized slice at the stem end of the tuber, examining it macroscopically and microscopically, and finally verifying the presence of the disease by isolating the pathogen in pure culture. Checks consisted of healthy potatoes of comparable size with the stem end trimmed in the same way as were the ring-rot potatoes Suspensions of *Erwinia carotovora, Erwinia phytophthora* and *Pseudomonas fluorescens* were made by washing 24 hour-old growth on potato-dextrose-peptone agar pH 6 9, with sterile distilled water

The cut ends of the tubers were smeared with the suspensions alone and in combination as shown in table 2. The tubers were placed in preparation dishes and in moist chambers containing a thick layer of well moistened paper towels. These were incubated at 28°C. Measurement of the resulting rot was expressed in centimeters. The results are presented in table 2. It is clear that the soft rot can easily be induced in ring-rot potatoes with *Erwinia carotovora, Erwinia phytophthorus,* and *Pseudomonas fluorescens.* On healthy tubers the above-mentioned species produce either no rot or a very insignificant amount of decay.

These findings, essentially in agreement with those of other workers, lead us to believe that the soft rot group of bacteria are, including the blackleg organism, primarily wound-followers and are devoid of invasive capacity. The evidence seems to point to the fact that we are dealing with a complex rather than with a distinct specific disease when we deal with soft rot of potatoes or even with blackleg.

Typical ring-rot potato hills do not have vines colored black as is the case with the so-called blackleg. No bad odor is present in the ring-rot disease before secondary invasion has occurred. However, the writer has seen ring-rot hills with soft rot complications in which blackened stems resembled very much blackleg and *Erwinia phytophthora* could be isolated from both the tubers and the vines. Table 3 shows the incidence of *Erwinia phytophthora* and saprophytic bacteria in the samples of the authentic ring-rot of potatoes.

The writer is inclined to think that under California conditions the blackleg disease can be a complex in which such organisms as *Erwinia carotovora, Erwinia phytophthora* or *Pseudomonas fluorescens* follow the path opened for them by some strong pathogen, such as *Phytomonas sepedonica* In some cases of blackleg, a strain of Rhizoctonia was isolated and proved to be pathogenic on young potato sprouts as was also observed by others (12)

The writer has noticed a very peculiar and almost habitual coincidence of *Erwinia carotovora* and blackleg in many potatoes affected by ring-rot disease grown in certain potato-producing areas in California. It is worth noticing that as soon as cleaner potatoes were planted in areas where ring-rot was very bad and more sanitation and precautions observed in handling the potatoes during the planting time, the drop in soft rot and blackleg was very significant. It is obvious that nothing could happen to soft rot bacteria in the soil, the only outstanding feature in the whole situation being new, clean seed free from ring-rot infection

In this connection the following statement made by Jennison (7),

TABLE 2 *Effect of certain bacteria on development of soft rot in detached tubers.*

Kind of Potato	Inoculated with	Examined after: Four Days after Inoculation	Examined after: Eight Days after Inoculation
Healthy	*Erwinia phytophthora*	Tuber 1—1 cm of rot 2—1 " " " 3—½ " " " 4—½ " " "	Tuber 1—2 cms. of rot 2.—1 " " " 3—½ " " " 4—½ " " "
Healthy	*Erwinia phytophthora* + *Erwinia carotovora*	Tuber 1—None 2—None 3—½ cm of rot 4—½ cm of rot	Tuber 1—None 2—None 3—1 cm of rot 4—½ cm of rot
Healthy	*Pseudomonas fluorescens*	Tuber 1—None 2—None 3—None 4—¼ cm of rot	Tuber 1—None 2—None 3—None 4—½ cm of rot
Ring-rot	*Erwinia phytophthora*	Tuber 1— ½ cm of rot 2—2 cms of rot 3—2½ " " " 4—2 " " "	Tuber 1—½ potato rotted 2—Complete decay of the whole potato 3—Ditto 4—Ditto
Ring-rot	*Erwinia carotovora*	Tuber 1—5 cms of rot 2—2 " " " 3—3 " " " 4—2 " " "	Tuber 1—Complete decay 2— " " 3— " " 4— " "
Ring-rot	*Erwinia phytophthora* + *Erwinia carotovora*	Tuber 1—4 cms of rot 2—2 " " " 3—2 " " " 4—2 " " "	Tuber 1—Complete decay 2— " " 3— " " 4— " "
Ring-rot	*Pseudomonas fluorescens*	Tuber 1—3 cms of decay 2—5 " " " 3—2 " " " 4—3 " " "	Tuber 1—Complete decay 2— " " 3— " " 4— " "
Ring-rot	None	No tubers showed any soft decay	No tubers showed any soft decay
Healthy	None	All tubers remained healthy	All tubers remained healthy

TABLE 3. *Bacteriological picture of the samples collected in the ring-rot fields in 1939-1940*

Type of Material	Number of Samples	Organisms Isolated:			
		Phytomonas sepedonica (pure)	*Erwinia phytophthora* (pure)	Mixture of 1 and 2	Miscellaneous
Tuber Sound on exterior Ivory yellow discoloration in vascular ring Typical ring-rot	85	85	0	0	0
Tuber. Cracks on exterior. Offensive odor Half of the tuber decayed.	112	0	0	90	32
Tuber About 75 per cent of the tuber decayed	75	0	25	3	47

namely "It appears to the writer that it still remains to be proven that the blackleg parasite can gain entrance to the vines or tubers through an unbroken epidermis" is of singular importance. On the basis of the reports in literature and the meager experimental evidence by the writer it does not seem unreasonable to consider the soft rot bacterium and the blackleg organism as "weakling parasites, *i.e.* only capable of parasitism on tissues previously weakened by some other cause," a conception long ago suggested by Jones (8).

Summary

1 The ooze test, *i e.* observation of the masses of bacteria coming out of the diseased tissues in water mounts under the low power has been successfully used in California in diagnosing ring-rot of potatoes. It is considered to be a presumptive test.

2. Incubation of seed pieces harboring the pathogen in a suitable substratum, such as peat-moss or soil at 28°C, reveals the disease in three weeks This may be helpful in ridding foundation stock of ring-rot

3 Proper disinfection of contaminated tools is to a great degree impeded by the slime present in infected potatoes.

4. Under California conditions, bacterial soft rot of potatoes is often secondary to ring-rot and it is believed that blackleg may also be secondary to ring-rot

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SECTIONAL NOTES

CALIFORNIA

At the present time we have a total of 61,600 acres of Irish potatoes planted in the floor of the valley in Kern County, except those which have been harvested during the past seven days Carload shipments began to move from Kern County on the seventeenth day of April, 1946. By the twentieth of April we had moved 181 cars by rail and approximately the same amount by truck. We expect our five heavy weeks of shipment to take place about the same time as that of last year Our heaviest shipments generally occur during the last two weeks in May and the first three weeks in June At the present time we are harvesting the best crop that has ever been harvested in our early section, commonly called the Edison district Unless some disease reduces the yield we are expecting the biggest yield, per acre, that this county has ever produced

We yet have about 3,000 acres of potatoes to be planted in the mountains The planting will take place during the latter part of May and the first part of June There will be several acres of the new variety known as Calrose ths year This variety moved into the market last year very satisfactorily Probably this season will be a good test of the acceptability of this variety by the trade and the consumer (Apr. 23)—M A. Lindsay

INDIANA

For the past month, Indiana has been warm and dry and we are in need of a good rain. Our potato planting is progressing very nicely. Our merchants and dealers are urging the public to use potatoes. We have plenty on hand and there has been some increase in the consumption per capita "Eat potatoes and save wheat" seems like a good slogan, but the proposed Government bonus for wheat production will not influence our potato program as the announcement came too late to cause any of our growers to alter their plans (Apr 26)—W. B WARD

KENTUCKY

Jefferson County growers have planted an estimated acreage of 4,000 acres,—mostly the Irish Cobbler variety Our planting began early in March and was practically completed by the 25th. Commercial fertilizer was applied at the rate of 6-800 pounds per acre,—the 6-8-6 is commonly used The potatoes have germinated and the stand, at present, is very good Although we have had a light frost no material damage has resulted The crop is apparently in excellent condition for this date. A little rain would help, however Our growers are planning to harvest their early crop between the 10th of July and the 10th of August.

They anticipate planting the second or late crop between the 15th of July and the first of August, at which time approximately 2,000 acres will be planted

Our growers, as a whole, are not too optimistic concerning the price situation

MICHIGAN

This state is experiencing one of the driest springs in many years. Our weather, in general, has been so favorable that farmers started planting operations at an early date and the work is not well advanced, but lack of moisture and high winds have somewhat delayed the germination.

Our early potato crop has been planted and indications are that the early crop in Michigan will be about equal to that of last season The late crop will be planted about the last of May and will be completed by the 15th of June Our acreage will probably be slightly larger than last year However, the increase will depend somewhat on the available supply of fertilizer.

Indications are that there will be an increase in the acreage of certified seed this year Russet Rurals will continue to be the leading

variety. There has been a decided interest in Russet Rurals in the past and a pronounced interest this season because of its exceptionally good chipping quality.

The certified seed deal is about completed with the entire crop being used for planting (May 4)—H. A Reiley.

MAINE

Maine will ship approximately 53,000 cars of potatoes this year on the basis of the May 1 shipment This is nearly 3,000 more than last year. The price has ranged from $3 50 to $4.00 per barrel,—net to the farmer,—which makes a rather profitable year, although smaller yields by some farmers indicate that it will not be profitable to all

This year, every one was surprised to discover that Green Mountains showed much less net necrosis than for many years. This might bring the Green Mountain back into a more prominent position

Our seed sales totaled about 7,700 cars compared with last year's 8,546, but on the basis of the Florida tests, Maine will plant better seed than ever before in its history.

Few of our farmers are treating seed this spring, not only because of the labor situation but also because rhizoctonia has bothered so little in late years. Practically the only variety that is still being treated is the Cobbler.

There is a distinct fertilizer shortage apparently due to the fact that UNRA has dipped into certain chemicals The general impression is that instead of increasing 2,000 acres to a total of 209,000 acres Maine will cut about 5 per cent.

The increase in support price recently announced was well received by the industry Several organizations vigorously protested the cut previously announced They are well satisfied with the announced support price, even though it is about five cents per cwt. less than last year (May 2)—Verne C. Beverly.

MISSISSIPPI

The harvesting of Irish potatoes will be about ten days earlier this year than last year. All indications point to the fact that the crop will be cut at least thirty per cent because of the weather. Recent rains, however, may increase this percentage. (May 2)—J E Snowden

NEBRASKA

At this date, we can only guess regarding the probable acreage to be planted in the late main crop areas of Nebraska Planting in the western high plains areas always starts about June the 10th, and is completed about the 25th,—if weather conditions are favorable.

Planting in the early crop table stock areas in central and eastern Nebraska began the latter part of March, and was practically completed by the middle of April. This was in contrast to delayed plantings, some of which were a month later during the past two years This season was extremely favorable for planting, and has continued to be so since that time.

The season has been warm, and one to two weeks in advance of what is considered normal In the western areas there has been some concern because of lack of moisture, but at this writing, (May 1), there has been a generally good rain over most of the territory, which has at least temporarily relieved the drought conditions

Referring again to the early areas of the state, reports indicate that the potatoes are showing a good stand, and our prospects are very good at this time

Applications for certification will be due in by the 10th of May. Preliminary indications are that this acreage will be about the same as last year More definite information will be available by the middle of the month.

Generally speaking, the western main crop growers were fairly well satisfied with the season. They grew a bumper crop of good to very good quality, and surprisingly enough, disposed of all of it A very small portion of the crop at the close of the season was shipped to alcohol and molasses conversion plants One such plant, located in Omaha, Nebraska, had previously used grain for their industrial alcohol and other products Because of the restrictions on grain, potatoes are being used to a great extent at this time. (May 1)—MARX KOEHNKE

NEW JERSEY

New Jersey potato growers experienced a rather favorable planting season this year,—some growers began planting by the 12th of March, and most of them were finished by the 20th of April. Many of the early planted potatoes are now above the ground and fair stands have been noted in most fields

Many growers have reduced their acreage this year and there will

be approximately 65 to 68,000 acres devoted to potatoes,—which is a reduction of 5 to 7 per cent below last year's acreage

There has been a deficiency in rainfall this spring so that in some areas our potatoes are in need of moisture.

Mr. Willis Morgan, the newly appointed Managing Director of the Potato Industry Committee of the New Jersey State Potato Association, assumed his duties on April 15 and has been active in contacting growers and members of the trade as well as certain officials of the Department of Agriculture in Washington. Most growers have indicated a willingness to co-operate in this new venture of the Potato Association by agreeing to pay an assessment of ½c. on each potato sack they purchase These funds will be used to improve the potato industry in New Jersey through a promotional and sales program (May 7)—J C CAMPBELL

NEW YORK

The normal acreage has been planted in Suffolk Co. and the plants are beginning to emerge. The ground, as a result of ample rains, is in very good condition

Because of serious losses in previous years, many farmers have treated their seed in order to prevent seed rot caused by Fusarium

Seed potatoes from every source are apparently infected with Fusarium, for, after being cut and stored for some time previous to planting,—a rot develops, under certain conditions

Our farmers are dissatisfied with the present reduced floor prices,—with labor costing two and one-half times pre-war costs, and with higher prices on all items. (May 5)—H. R. TALMAGE.

NORTH CAROLINA

The early commercial Irish potato crop in eastern North Carolina is making good progress The growing season has been good and all sections have escaped frost. They should now be safe from this hazard.

Our latest reports from growers indicate that 31,000 acres have been planted as compared with 26,000 acres for 1945 The 1946 acreage is approximately 9 per cent below the ten-year (1935-1944) average,—as reported by the Federal-State crop-reporting service. The condition is reported as being 92 per cent of the normal Because of favorable growing conditions, our crop is from ten days to two weeks earlier than usual which means that harvesting will begin in some areas about the middle of May

Irish Cobbler is still the standard variety, but some sections have planted Red Warba, Pontiac and Sequoia (April 22)—M E GARDNER

OHIO

Planting of early potatoes started in southern Ohio during the latter part of March Favorable planting weather continued throughout April Therefore the early plantings were completed by the early part of April, —much earlier than usual This will mean that harvesting dates from the southern to the northern section will be almost simultaneous

Many growers have planted late potatoes where fertilizer deliveries have been made, but plantings are now being delayed because of the lack of fertilizer.

Since DDT will be available for leafhopper control, potatoes are being planted much earlier than in previous years.

The acreage in Ohio will be about the same as last year Some growers are reducing their acreage, whereas others are increasing it, so that this will make the crop about the same.

This past year more potatoes were marketed in consumer packages than in any previous year and prospects point toward a greater use of small packages.

A few years ago the Rural Russet was the predominant variety in Ohio Last year about 50 per cent of the acreage was Cobblers, 40 per cent, Katahdin, the remainder, Russets and miscellaneous varieties. Chip manufacturers are encouraging growers to plant more Russets and as the result there is a small increase in the use of this variety

Growers are not enthusiastic about the Brewster Potato Bill. The acreage in Ohio has been cut materially during the last few years, although acreage increases have been greatest in the distant shipping areas (May 4)—E B TUSSING

PENNSYLVANIA

Spray ring organization has reached the point where it is now familiar to most potato growers in the state Education tending toward the organization of new rings has occurred only where the need has been expressed on a community basis Since 1938, when the first rings were organized, the work has now grown, in 1945, from four to 101 rings. Through these rings, 17,372 acres were sprayed for 2,124 farmers This is an average of 8 1 acres per farm, showing that community spraying has made possible disease control where the expense of owning and oper-

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ating a sprayer individually would raise the expense of the operation to a prohibitive extent Ten spraying demonstrations were conducted. The average increase in yield from the use of Bordeaux was 135 bushels per acre. Using this figure as an index of state increases, then spray rings increased production by 2,345,220 bushels and the farmers income of the state by approximately $4,000,000 (April 25)—O D. BURKE.

VERMONT

"Larger acreages—smaller acreage" That's the story in Vermont potatoes—a rather surprisingly strong swing toward large acreages by a small number of growers, but a smaller total state acreage than in pre-war times and very, very much smaller than in pre-World War I times

Just how closely this follows a national trend your writer does not know. Perhaps, in any event, details of the situation may be of interest for comparative purposes

The census of 1910 credited Vermont with 30,000 acres of potatoes From that time down through the early 1920's there was a fairly gradual decrease The B A E figure for 1923 was 24,000 acres The next ten years cut it down to 16 or 17 thousand, and the average for the past five years has been around 12,000 If we had wished to start this chronology off at the real high peak of Vermont potato acreage we should have gone back to 1877, with 47,000 acres, but that was in the local starch factory era. The last 30 years tells the story better and the story is, in the main, that of a swing from general to specialized farming Being pre-eminently a dairy state this specialization has run to dairying. The boys who are making dairying their profession naturally have no time for raising a side line of potatoes Especially is this true now that the market demands something considerably better than the old carload bulk shipments of "potato buyer" days. But here and there have been men who liked to grow potatoes and who have seen a future in doing it With these the specialization went into potato growing Others seeing these men successful have worked their own way into the game The total number of these growers, new style, is not great—Vermont is still predominantly a dairy state and probably will long remain so—but the development is none the less impressive

Fifty-acre lots are not much in some parts of the country. They are big in Vermont A few years ago they were all but *nil* Within the past ten years, growers of 50 to 100 acres have become common, if not common, at least frequent and one—Fred W Peaslee of Guildhall—reached an all time high for Vermont of 165 acres.

With these step-ups in acreage by various growers has come the need and the materialization of warehouses Of the larger growers who have put up such up-to-date storages quite recently are C J. Batten, East Hardwick; W. S Hill, Hardwick; Salls Brothers, Morrisville, W. A. Wheeler & Sons, Jericho; Howard Rowe, Guildhall, and Truman Wright, Lunenburg. Earlier but not too long ago, pioneer houses were built by the Dimock Corporation at Bellows Falls (now the Hardy A Merrill warehouse), by Fred W. Peaslee at Guildhall and two houses by a community corporation at Greensboro Most of these storages vary from twenty-five to thirty thousand-bushels capacity and accommodate one or more other growers besides the owners.

Modern grading equipment and trained grading crews are, of course, a part of this development and most of the table stock goes out in peck packs. Nearly all of these growers have been long time producers of certified seed as well as table stock. The fact that machinery, which is necessary, under present labor conditions, to produce a few acres is usually good for much larger acreages doubtless is a contributing factor and economists could give us more.

How long it will be before the expanding acreage of the comparatively few larger growers overbalances the dwindling acreages of the many smaller ones to the point of upping the state's total could perhaps be figured out, but no one probably would care to wager too much on the accuracy of the answer. Meanwhile agricultural authorities see in the movement a healthy trend which probably will go considerably farther. (May 3)—Harold L. Bailey.

WASHINGTON

According to my memory we have had one of the coldest and wettest springs ever experienced in Washington The result is that very little farm work has been completed at the present time,—except in the irrigated sections West of the Cascades, planting has been completed only on the driest, most well-drained land Very few potatoes have been planted and those that have been planted show little sign of germination at the present time.

Today is more spring-like than any day we have experienced this season. The sun is shining and it is quite warm, and we are hopeful of better days to come.

Cabbage seed crops have suffered one-third loss because of excessive water. Spinach, beets and mangels are only partly planted and much of the ground is still too wet to make a good seed bed

Growers are somewhat reluctant to sign up for vegetable seed acreage because of the drop in contract price paid. Our Association does not contract at a price, but merely contracts to sell the crop for a selected group of growers. It is our intent to place acreage only with those members of the Association who have soil well adapted to the particular kind of seed crop that they wish to grow. (April 25)—CHAS D GAINES.

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STORAGE CONDITIONS WHICH AFFECT THE VITAMIN C CONTENT OF MAINE-GROWN POTATOES

Elizabeth Murphy

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The significance of the potato (*Solanum tuberosum*) as a vehicle for the essential food factors is becoming more and more apparent. It has been observed (3) by means of a technique which relates biochemical values to consumer acceptance that the white potato, while ranking relatively low in many nutritive essentials when compared per unit quantity to "rich" sources of these factors, becomes a food of major nutritional importance when consumer appetite is evaluated. As a result of five consumer surveys, it was concluded that "Potatoes rank among the high 50 (foods) for all nutrients except vitamin A. If the consumer could be induced to accept vitamin A in the potato (a high probability), the potato could stand *first* as a basic food." Yellow flesh color characterizes many of the existing varieties (15). This may be associated with vitamin A activity or may merely indicate the presence of inactive carotenoids.

Specifically, the vitamin C of potatoes was compared to that of cabbage, collards, broccoli, kohlrabi, turnips, and tomatoes and found to rank sixth When the same values are calculated according to appetite level, the relative order of importance changes strikingly and the potato ranks first, (2).

In a study of the vitamin C nutrition of a group of Maine school children (1, 13), it was found that potatoes provided the chief supply of this substance in the diets The amount furnished from this source was apparently large enough to prevent the manifestation of the usually recognized symptoms of clinical scurvy.

The contribution made by the potato to the vitamin C needs of populations is subject to many influences The value of newly harvested tubers depends primarily upon the variety and almost to as great an extent upon the environmental conditions under which they are produced. The exact factors conducive to optimum vitamin C synthesis are as yet not fully known nor understand. Light intensity, water supply, and temperature may all play a vital role (15).

The effect of storage on vitamin C is of significance because the bulk of the potato crop is submitted to holding for a greater or lesser period of time and under varying conditions before final consumption.

The relatively large decrease in the vitamin C content of potato tubers during storage has been pointed out by several investigators (18, 19, 21, 23, 24, 25, 26, 28) Some of these observed a steady decline (19), while others noted a sharp reduction during the early part of storage with a gradual and slower loss in the later part (7, 17, 29). A few suggest that the rate of loss is dependent upon the initial value *i.e.* high-testing potatoes lose vitamin C at a faster rate than low-testing ones thus reducing varietal differences (5, 6, 16, 17, 28) while others report no change in the relative rank of varieties after storage (25). Recently some observers have investigated the relationship of temperature to vitamin C loss in potatoes during storage. Pett (16) noted slightly better retention in three varieties stored at 15° C. than at 10° or 5° C Mayfield *et al* (9) recorded figures showing somewhat less loss in two varieties stored at 55 to 60° F. than at 37 to 46° F. Julén (6) worked with twelve varieties and found that those stored at 18 to 20° C were superior in vitamin C values to those at 2 to 3° C. Rolf (17) found that two varieties retained more vitamin C at 15 5° than at 4.5° C Karikka *et al.* (7) found 50° F to be more favorable to retention than 40° F. in the one variety tested. Werner (27) reported that potatoes lose least vitamin C when stored between 50 and 70° F., with increasing losses as the temperature is lowered. Esselen *et al.* (5) found comparable losses in two varieties of potatoes stored at 36° F. and at 40° to 50° F, smaller losses at 36° in two other varieties, and larger losses at 36° in four varieties.

In a previous report (15) it was shown that newly dug raw potatoes may contain vitamin C comparable to the amounts present in field-

ripened tomatoes The determination of the optimum storage conditions commensurate with high quality tubers was the objective of continued study

PROCEDURE

Six varieties which were representative of the range of vitamin C values as determined previously (15) were chosen for the investigation.

In 1943-1944, preliminary observations of the vitamin C of these six varieties during storage at five temperatures were made.

Varieties. Tubers of Green Mountain, Irish Cobbler, Katahdin, Chippewa, Sebago, and Mohawk were secured from Aroostook County, Maine, in the fall of 1943

Production Practices: Some of the varieties were purchased and others obtained from experimental plots designed for purposes other than nutritional investigation All were grown in and around Presque Isle so the soil was Caribou loam with the soil pH approximately 4.8 to 5 5 Greater than average rainfall prevailed during August in 1943.

Maturity. At harvest time probably only Irish Cobbler and Chippewa tubers were mature if complete death of the vines is used as the criterion for maturity.

Holding Conditions Samples of the tubers were received on the 9th of October and held in a root cellar until the 27th before the first analyses All the remaining tubers had been placed in storage on the 9th of October. The temperatures of the bins were controlled at 32°, 36°, 50°, 65°, and 70° F. Four tubers of each variety at each temperature were removed at monthly intervals and analyzed for ascorbic acid Total solids were not determined except for an occasional sample.

Method: The Loeffler and Ponting (8) technique was used for the determination of vitamin C using 1 per cent HPO_3 as an extractant Aliquots of the extract with dye indicator were read in a Klett-Summerson photoelectric colorimeter

In December, ten pairs of samples, each pair consisting of adjacent sectors from the same tubers and representing all five varieties from the 32° bin and the 70° bin, were analyzed by the Loeffler and Ponting (8) and by the Morrell (11) methods, the former colorimetric using 1 per cent HPO_3 and the latter titrimetric with 5 per cent HPO_3. The values obtained by the Morrell method averaged 1 04 mg per 100 grams higher (12 4 per cent) than the Loeffler and Ponting As the original values and those after one month's storage had been determined by the Loeffler method, this technique was adhered to throughout the experiment.

Sampling Radial sectors (bud to stem end) from two tubers constituted a sample. Duplicates consisted of opposite sectors Two other tubers were treated similarly and the average of the four determinations was the value assigned to the sample.

RESULTS 1943-1944

The data in mg. per 100 grams resulting from ascorbic acid tests on the stored potatoes were statistically analyzed by the variance method. Highly significant differences were found to exist between varieties, months, temperatures, and the interactions of months with varieties, months with temperatures, and varieties with temperatures.

Varietal differences in vitamin C were found, with Mohawk and Irish Cobbler showing the highest values and Chippewa the lowest. A loss of this vitamin occurred during the seven months in storage. The varieties averaged 17 3 milligrams of vitamin C in October and 6 0 milligrams per 100 grams in May.

The higher temperatures of 50°, 65°, and 70° F. were conducive to better retention af ascorbic acid than were the 32° and 36° F. temperatures. Over the period of seven months it appeared that neither 65° nor 70° was superior to 50° F. although in the earlier months 65° or 70° temperature sometimes was associated with the highest value for the particular month. The quality of these tubers, however, was inferior to those at the lower temperatures. There also appeared to be a difference in varietal response to the temperature and the duration of storage The vitamin C content of Mohawk and Green Mountain tended to be relatively more resistant to oxidation than the other varieties.

The detailed analytic results are not presented here because of the preliminary nature of the 1943-1944 work and because cultural practices were not rigidly controlled. The pertinent data are included with the second year's results which are reported below.

The tentative conclusions drawn from this prefatory investigation stimulated further study during the following season using tubers produced under controlled experimental conditions.

PROCEDURE 1944-1945

Varieties: Tubers of the same six varieties were obtained from the U S.D.A. experimental plots[1] at Presque Isle, Maine.

Production Practices: The potatoes were grown under similar and controlled cultural conditions. The plots were grown with five repli-

[1]Grateful acknowledgment is accorded to F. J. Stevenson and R V Akeley for supplying the potatoes

cations and an equal number of tubers was taken at random from each of the six plots. The soil was Caribou loam with a pH of approximately 4.8 to 5 5.

Maturity· Probably only Irish Cobbler and Chippewa were mature when harvested.

Holding Conditions: The potatoes were harvested on the 19th and 20th of September and placed in the storage bins on the 22nd of September. Samples were transported to the Orono laboratory on the 23rd and held in a cool root cellar until the 25th when they were analyzed for vitamin C The storage bins were controlled at 32°, 36°, 50°, 60°, and 70° F Records show that in all of the bins the average variation in temperature was not more than 1 5 degrees.

Method The Loeffler and Ponting (8) method was used to determine vitamin C in 30 to 40 gram samples of potatoes.

Before attempting the second experiment, it was desired to ascertain if a more concentrated HPO_3 solution would more effectively extract vitamin C from the potato tissue. It was necessary to investigate this point before tubers of the chosen varieties were available. Therefore, on September 1st, freshly harvested Harmony Beauty potatoes were secured for this preliminary test.

Eight sets of three samples of adjacent sectors of Harmony Beauty tubers were extracted with 1 per cent, 3 per cent, and 5 per cent HPO_3. The resulting values were analyzed by the variance method with the following results:

Treatments	Average Mg. per 100 Grams
1% HPO_3	24.8
3% "	22 9
5% "	23.6

Difference of 18 mg. necessary for significance at 5 per cent
Difference of 25 mg. necessary for significance at 1 per cent

The 1 per cent extractant resulted in significantly higher values but significant differences were also apparent between replicates. For the second season, the Loeffler and Ponting method with 1 per cent HPO_3 was used throughout the period

Total solids were determined on all samples by drying ten grams of chopped potato in a steam oven for sixteen hours.

Sampling· Six tubers of each variety from each bin were shipped monthly. The first interval in 1944 was longer than a month in order to

make the testing dates comparable to 1943. They were usually analyzed the day following removal from storage. In January and February testing was delayed until the second and the third day respectively after removal from storage due to late express delivery.

Unpeeled radial sectors (bud to stem end) from each side of three tubers were composited for analysis. Duplicates consisted of sectors from three other tubers. Adjacent sectors were taken for determination of total solids.

The samples were ground in a Waring blendor with 350 ml. of 1 per cent HPO_3 for five minutes, filtered through Whatman No. 42 filter paper, and aliquots of 1 ml. of the filtrate with 9 ml. dye indicator were read in the Klett-Summerson photoelectric colorimeter. Corrections were made for turbidity. The ascorbic acid content was calculated on the basis of 79 per cent moisture in potatoes (12) although moisture determinations were made on all samples. All the Green Mountain and all the Chippewa samples at 32° and 70° were recalculated on the basis of the actual moisture content, and the resulting vitamin C values were compared by variance analysis to those obtained by using the 79 per cent average. This comparison to the fourth decimal place gave a variance value of zero so the results reported herein are based on figures using the average moisture content of potato tissue.

The contingency that adjustment for weight loss of the tubers might diminish or even nullify the favorable effects of high temperatures on the vitamin C retention in stored potatoes was given consideration.

The potatoes were weighed individually on the day after harvest and the weight was written on the tuber with indelible pencil. They were again weighed when removed from storage for analyses. Total weight loss, including as it does losses from disease as well as those incidental to respiration and transpiration, seemed to constitute a much more valid basis for recalculating vitamin C concentration than total solids, which measure only transpiratory losses. The average loss in weight at 60 and 70° F. was approximately 15 per cent whereas at 50, 36, and 32° F. it was 6.0, 4.6, and 7.0 per cent respectively. Sebago lost significantly more at all temperatures than the other varieties.

The observed vitamin C values were recalculated on the basis of the original weights of the tubers, and the data were evaluated by determining that value in a comparison of the groups. This treatment shows that the observed amounts are significantly higher than those adjusted for weight loss. Although the differential between the values ascribed to high and low temperature is somewhat diminished, the conclusions are unchanged, and the favorable influence of 50° F.

TABLE I—*Comparison of actual vitamin C values and those adjusted for tuber weight loss*

Temperature °F.	Mg. per 100 Grams	
	Actual Ave.	Adjusted Ave
32	12 1	11 6
36	11 0	10.7
50	15 0	14 4
60	13 5	12.5
70	13 6	12.5
Variety		
Mohawk	15 3	14 6
Green Mountain	12 0	11 3
Sebago	12 2	11 3
Irish Cobbler	13 1	12 4
Chippewa	10 7	10 1
Katahdin	14 9	14 3
Month		
1	19 3	18 8
2	14 2	13 6
3	10 2	9 7
4	10 1	9.3
5	7 3	6.6
6	7 7	6.5
7	7 4	6 1
	t value	Significance at the 1 per cent level
Temperatures	4.9	4.6
Months	6.3	3.7
Varieties	15.5	4.0

over the lower temperatures is not erased as shown in table 1 As it was desired to use both seasons' results for complete analysis and as the actual observed value at any given time is the only one of significance for consumer information, the values adjusted for loss in weight will not be dealt with further.

Results 1944-1945

Six varieties of fresh raw potatoes averaged approximately 63 per cent higher in vitamin C content in 1944 than the same varieties in 1943 (28.1 in 1944 and 17.2 mg per 100 grams in 1943). There may be several reasons for this relatively large difference In 1943, the tubers were not grown under controlled cultural conditions. They were received at the laboratory on the 9th of October and were not analyzed until the 27th so that losses involved in potatoes stored in a cool cellar for at least 18 days occurred. It is not known how long a period of storage prior to the 9th of October was imposed on the tubers, although this period was probably not longer than one week On the other hand, the 1944 tubers were known to be held only five days before analyses were started. This circumstance certainly favors higher value for 1944. The relative immaturity of the 1944 potatoes may have been somewhat responsible for increased amounts. The tubers of that year were harvested earlier by at least fourteen days than was probable the previous year. This also would favor higher 1944 values as immature potatoes have been shown to contain more vitamin C than mature ones (21, 27, 29) When the "between season" differences are compared at the first testing date, 1944 shows an average advantage of 10 9 mg If the comparison is made arbitrarily between the first tested 1943 tubers and those of 1944 after the first storage period, the differential would diminish to 2.1 mg. Weather conditions may have had some influence on the vitamin C values. The rainfall from the 1st of June to the 1st of October was 14 58 inches during 1943 and 13.16 during 1944 For August, however, 4.41 inches were recorded in 1943 and 1 42 during 1944.

The 1943-1944 and 1944-1945 data were combined and submitted to an analysis of variance which demonstrated that significant differences existed between varieties, months, temperature, years and their interactions as given in table 2.

Variety: Mohawk exhibited the highest average vitamin C value for both years with Katahdin and Irish Cobbler second and third, respectively, and Chippewa lowest.

Freshly dug potato tubers show significant differences between varieties. The decided effect of season on these values does not change the relative rank which each variety holds in respect to others although the absolute amounts may be increased 100 per cent under the influence of a favorable environment (15).

A variety of high genetic quality might lose its advantage to the

TABLE 2.—*Vitamin C content of stored Maine potatoes. Combined* 1943-1944 *and* 1944-1945 *data analyzed by variance method. Mg. per* 100 *grams*

Variety	Ave.	*vs* Months Stored							
		0	1	2	3	4	5	6	7
Mohawk	13 2	24 4	18 0	15 0	•10 3	10 8	9 0	10.5	7.6
Green Mountain	10 4	18 9	14.9	10 5	8.4	9 4	7.6	7.1	6.0
Sebago	10 6	24.3	15 3	11 2	8.8	7.7	5 8	6.1	5 6
Cobbler	11 7	25 3	16 9	12 5	8 3	8.9	7.9	6.8	7.3
Chippewa	9 1	18.1	13 3	9 5	8 1	7.2	5.5	6.4	4.9
Katahdin	12 2	25.2	17 3	13 6	10.5	8 8	7 7	8.6	6 3

L S. D. at 1 per cent, 45 mg.
L. S. D. at 5 per cent, .34 mg.

L. S. D. at 1 per cent, 1.26 mg
L. S. D. at 5 per cent, .96 mg.

Temperature	Ave.	Mohawk	Gr Mt.	Sebago	Cobbler	Chippewa	Katahdin
32° F.	10.1	15 3	8 7	8 0	9.2	8.4	10.9
36° F.	9 2	11.0	8.7	8.6	9 1	7.9	10 0
50° F.	12.7	14.6	12.2	12 7	13.2	9 6	14.0
60° F.	13 6	14.8	13 4	13.0	14.5	10.4	15.2
65° F.	10 7	11 3	9.8	11 0	12.1	8.9	10 9
70° F.	11.9	12 1	10.6	11.8	13.9	10.0	13 2

L. S. D at 1 per cent, .31, .44* mg
L S. D at 5 per cent, .41, .58* mg.

L. S. D. at 1 per cent, 1.00, 1 41*
L. S D. at 5 per cent, .76, 1.07*

*L. S. D. for temperatures 60° and 65°.

TABLE 2 (Continued).—*Vitamin C content of stored Maine potatoes Combined 1943-1944 and 1944-1945 data analyzed by variance method. Mg. per 100 grams*

Month	Ave	32°	36°	50°	60°	65°	70°
0	22.7	22.7	22.7	22.7	28 1	17.2	22.7
1	15 9	14.8	12.5	18.4	19 8	14.6	16 9
2	12.0	9.3	8.5	14.1	16 6	12 9	13.5
3	9.1	7.0	5 8	11 3	12 5	10 3	9.9
4	8 8	6.2	5.7	10.6	12 3	8 6	11.1
5	7.3	6.5	5.7	8.5	6.4	9.3	7.7
6	7.6	7.7	6.6	8 4	6 9	7.6	8 0
7	6 3	6.3	6 3	7 9	5 8	5 0	5 5

L. S. D. at 1 per cent, .52 mg
L. S D. at 5 per cent, .39 mg.

L S. D. at 1 per cent, 1 15, 1.63*
L S. D at 5 per cent, 88, 1 24*

Years	Ave	0	1	2	3	4	5	6	7
1943-1944	9.3	17 2	11 9	9.9	8 0	7 6	7.2	7 5	5.1
1944-1945	13 1	28 1	20 0	14 2	10 2	10 1	7 3	7.7	7 4

L. S. D. at 1 per cent .52 mg.
L S D. at 5 per cent .20 mg

L. S. D at 1 per cent, 73 mg
L S D at 5 per cent, 55 mg

*L S. D. for temperatures 60° and 65°.

consumer if this characteristic is not maintained during storage. Schrumpf (20) has determined that during the past five years an average of only 6.6 per cent of the Maine potato crop was shipped to markets in October (the year 1943 was omitted in deriving this average because the extremely large crop taxed storage facilities and necessitated shipping unusual amounts during the harvest month for storage elsewhere). In January, 14.4 per cent of the crop left the State This amount probably constitutes the peak for table purposes. The higher percentage in March (19.5) undoubtedly reflects large purchases of seed potatoes.

To determine the effect of storage on varietal differences in vitamin C, the values for October, January, and May were analyzed by the variance technique. The pertinent information resulting from this treatment is shown in table 3.

TABLE 3—*The effect of storage on varietal differences in potato tubers —vitamin C (Mg per 100 grams)*

Variety	Fresh (Oct)		3 Months (Jan)		7 Months (May)	
	1943[1]	1944[2]	1944[1]	1945[2]	1944[1]	1945[2]
Mohawk	18 5	30 3	10 6	12 3	6 6	10 0
Gr. Mt.	13 7	24 0	8 4	9 3	6 1	6 8
Sebago	18 7	29 8	8 3	9 1	5 4	6.5
Irish Cobb	20 4	30 1	8 5	9 3	7 0	7 9
Chippewa	13 0	23 1	7 7	8 3	4 4	6 3
Katahdin	19.0	31.4	8 7	12 7	6 3	7 0

[1]L. S. D. between varieties: at 1 per cent, 2 1; at 5 per cent, 1.5 mg
[2]L. S. D. between varieties: at 1 per cent, 1 7; at 5 per cent, 1 3 mg

Of the fifteen possible varietal comparisons, ten were found to vary significantly in October of both years, decreasing to five and eight in January and five and seven in May of 1944 and 1945, respectively.

In order to express the magnitude of this decrease in varietal difference over time, an arbitrary value was derived by totalling the deviations from all possible comparisons. In this manner, the entire variability ascribable to variety in October 1943 was 53.1 mg, in January 15.8 mg., and in May 16 8 mg. In 1944, a larger decrease in total variability occurred, from 60.7 mg in October to 31.6 mg in January and 22 9 mg in May Thus, when judgment is based on six varieties, the differential between varieties diminished from 30 to 52 per cent after three

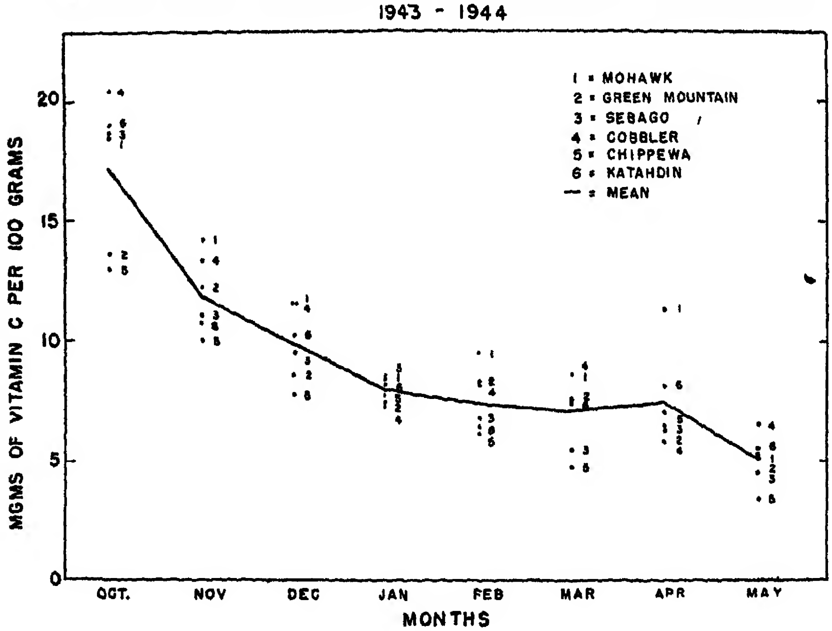
or seven months' storage. As the varieties are examined separately, however, it is seen that some maintain a consistent and significant superiority during holding although the magnitude of the superiority decreases.

This shrinkage of varietal differences for each variety at each month is shown in figures 1, 2, and 3.

In 1943 (Fig 1), the relatively large differences gradually contracted during the first three months' storage and were at a minimum in January. Thereafter, they became slightly larger. Mohawk always

FIGURE 1

AVERAGE VITAMIN C VALUES OF POTATOES STORED AT 5 TEMPERATURES 1943 - 1944

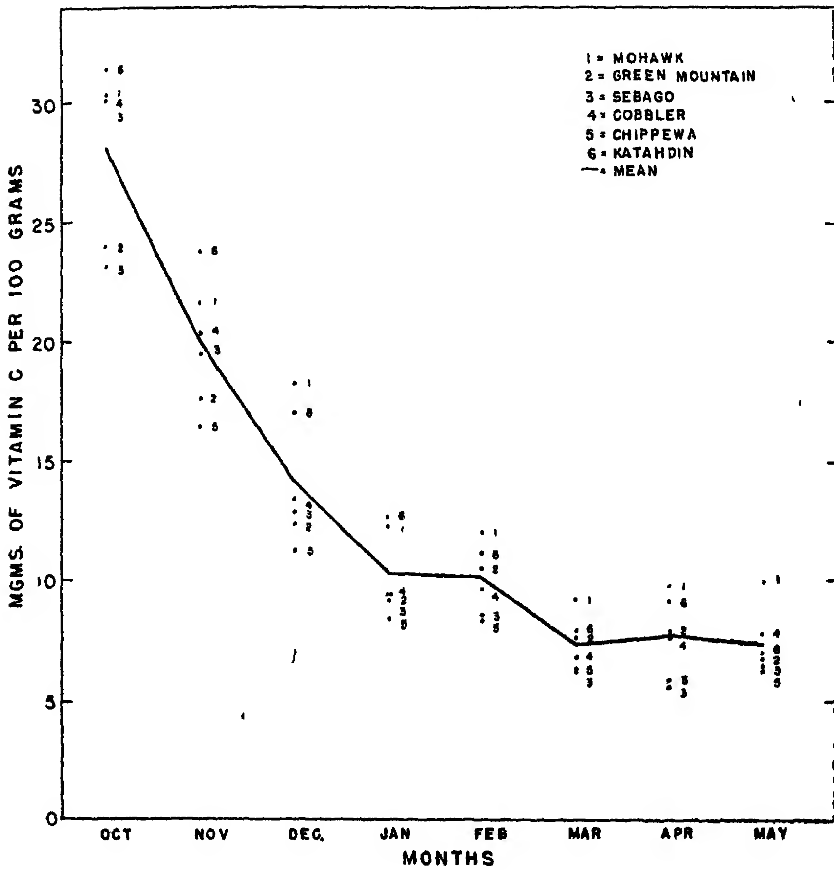


maintained a position above the mean with Katahdin and Irish Cobbler closer to the mean but usually above it. Green Mountain, which in October was far below the average, gradually increased in relative value whereas Sebago lost its superior position rapidly and remained in a low place. Chippewa was low throughout the storage period

The 1944 data, recorded in figure 2, generally confirmed the earlier results, demonstrating that varieties show inherent differences in their response to storage conditions. Minimum differences occurred later in the storage period—in March 21.2 mg. and February 26.1 mg.—with a

FIGURE 2

AVERAGE VITAMIN C VALUES OF POTATOES STORED AT 5 TEMPERATURES. 1944 - 1945



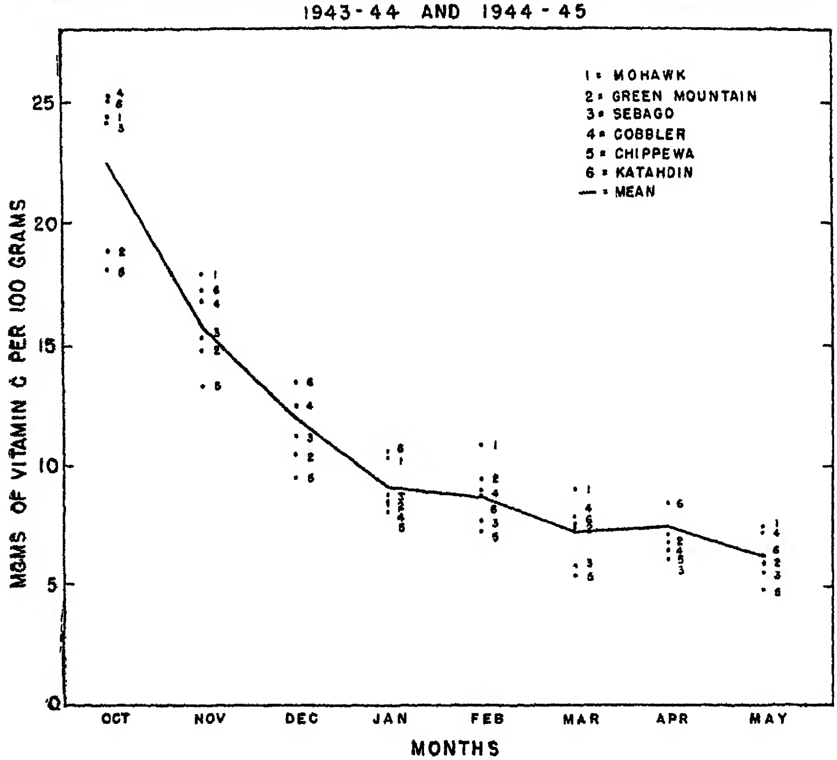
subsequent increase. (This is not apparent in the variance analysis of table 3 as January showed wider variations than May.) Most of the varietal reactions were similar to those of the previous season. Mohawk was well above the mean at all testing periods and Katahdin maintained its advantage. Sebago again dropped rapidly to the low level of Chippewa. Green Mountain improved its relative position. Irish Cobbler was not consistent, however, but fell below the mean at five testing periods compared with two in the previous year.

Figure 3 pictures the combined data for both years.

The obvious difference in varietal response to temperature and dura-

FIGURE 3

AVERAGE VITAMIN C VALUES OF POTATOES STORED AT 5 TEMPERATURES 1943-44 AND 1944-45



tion of storage led to additional analyses of the data in terms of percentage losses, as shown in table 4

Although the initial values were approximately 63 per cent greater in 1944 (28.1 mg. per 100 grams) than in 1943 (17 2 mg. per 100 grams), the percentage loss of vitamin C was greater in the latter year.

The probability arises that not only the 1943 lower values but also the slower rate of loss in that year were due to the longer interval between digging and testing (18 to 25 days in 1943 and only five days in 1944). Assuming a considerable loss prior to analysis in 1943, the greatest difference between the years should then occur during the first month's storage. This was not the case, however, as the average first month's loss in 1943 was 30 and in 1944 was 31 per cent. The third and the fifth months seem to account for the greatest discrepancy between years although the varieties do not always react similarly.

TABLE 4.—*Percentage losses of vitamin C from stored potatoes*

Variety	1943-1944	1944-1945	Months	1943-1944	1944-1945	Temperature	1943-1944	1944-1945
Mohawk	44	56	1	30	31	32°	59	65
Green Mountain	40	57	2	43	50	36°	63	69
Sebago	60	67	3	48	64	50°	45	53
Irish Cobbler	55	65	4	52	64	60°	..	59
Chippewa	49	62	5	59	74	65°	42	
Katahdin	57	60	6	59	73	70°	45	59
			7	65	74			
L S D	1 per cent—5 5 per cent—4	1 per cent—4 5 per cent—3		1 per cent—6 5 per cent—4	1 per cent—4 5 per cent—3		1 per cent—5 5 per cent—4	1 per cent—3 5 per cent—2

	1943-1944					1944-1945				
	32°	36°	50°	65°	70°	32°	36°	50°	60°	70°
Mohawk	35	56	36	42	52	44	66	51	59	62
Green Mt	55	52	29	31	32	64	63	47	51	59
Sebago	74	73	51	48	52	76	75	58	65	63
Irish Cobbler	67	69	53	43	43	76	78	55	60	55
Chippewa	55	58	50	40	40	64	66	58	63	58
Katahdin	65	72	52	47	50	65	67	51	58	58

L. S. D. 1 per cent—11, 5 per cent—9 (1943-1944); 1 per cent—8, 5 per cent—6 (1944-1945)

TABLE 4 (Continued).—*Percentage losses of vitamin C from stored potatoes*

Months	1943-1944						1944-1945					
	Mohawk	Mt	Seb.	Cob.	Chip	Kat.	Mohawk	Mt	Seb	Cob.	Chip	Kat
1	23	15	41	35	23	43	32	26	36	35	31	27
2	36	35	55	45	36	50	40	48	57	56	52	46
3	43	39	56	58	41	54	59	61	69	69	64	60
4	47	37	57	59	49	61	60	56	71	68	64	65
5	54	45	72	57	62	62	70	68	80	77	73	75
6	43	51	67	66	64	62	68	67	81	74	74	71
7	64	56	71	66	66	67	67	72	78	74	73	78

L. S. D. 1 per cent — not significant
5 per cent—10

Not significant

Months	1943-1944					1944-1945				
	32°	36°	50°	65°	70°	32°	36°	50°	60°	70°
1	36	42	24	17	31	29	47	22	31	27
2	58	58	39	25	24	59	64	39	42	45
3	62	64	42	34	40	70	78	52	55	64
4	58	68	49	43	39	80	76	53	56	55
5	72	73	55	47	47	73	76	67	77	75
6	57	68	53	59	57	72	74	71	75	70
7	67	70	54	68	66	72	70	68	79	79

L. S. D. 1 per cent—12
5 per cent— 9

1 per cent—9
5 per cent—6

In both years the greatest loss occurred during the first month's storage—from ⅓ to ½ of the total loss occurred in this month for most varieties. During the last two or three months, a stability was achieved and very little added loss took place even at the unfavorably low temperatures.

Variety: When both years' data are reviewed, it would appear that a genetic constancy is evident in the varietal response to storage conditions On the basis of percentage losses, which in fact indicate rate, it was apparent that Green Mountain and Mohawk lost vitamin C at a relatively slower rate than Sebago. The other three varieties tended to be less predictable, although Katahdin showed comparative stability in 1944-1945. Mohawk variety presented an anomaly by being the only one which showed comparatively high retention at 32° F. during both years This was obvious even after the tubers were affected with severe internal mahogany browning.

Temperature: Although the higher temperatures *i e.* 50° F. or above, effected higher vitamin C values during storage, the losses over time at all temperatures were extremely large. The average losses after seven months' storage were over 65 per cent and after only three or four months, when the bulk of the potato crop is ordinarily removed for shipment, the losses averaged from 48 to 64 per cent. In the first season 65° and in the second 50° F. were favorable to the smallest average losses although the difference between these and the other high temperatures was slight When physical quality is also considered, 50° F. is vastly preferable to the higher storage temperatures. Both 32° and 36° F. induced relatively larger vitamin C losses.

Time: The discrepancy in rate of vitamin C loss between the two low temperatures and the three high ones is more pronounced in the first three months after which period the tubers at 32° and 36° seem to have undergone a maximum loss Subsequent months caused only small additional changes. The higher temperatures continued to bring about relatively larger decreases until the fifth month when the values became approximately of the same degree of magnitude as those at the low temperatures During the sixth and seventh months, no further losses occurred in 1945 although a significant added loss was apparent during the last month in 1944. A further examination of the data showed that a relatively large loss during the seventh month by Mohawk (from 43 to 64 per cent) was chiefly responsible for this discrepancy between years. The observation was not confirmed in 1945.

It is difficult to compare the results of this investigation with those reported in the literature as neither the temperatures nor the varieties

are comparable. That relatively high storage temperatures are conducive to significantly higher vitamin C values in potato tubers is confirmed. In addition, with these varieties and under the conditions of this experiment, 50° F. was as favorable as 60°, 65°, or 70° F. for vitamin C retention If this holds true under all conditions, it at least fixes the temperature requisite for maximum vitamin C retention at a point associated with palatability although 40° F. or slightly below is recommended for long-continued holding (4). Methods that would prevent the extremely large initial losses observed at all temperatures would be very desirable.

Season. The average vitamin C value of these six varieties was approximately 63 per cent higher in 1944 (28.1 mg.) than in 1943 (17.2 mg. per 100 grams) The advantage is maintained throughout the storage period although the large differences apparent during the first two months gradually diminish In the fifth and sixth months, the average difference between years is not significant

The reason for this levelling of "between season" and "between variety" values is not known. When vitamin C is high either by reason of genetic constitution or of a favorable environment, it appears that a fraction of the vitamin is more responsive to destructive agents Gradually or abruptly a more stable minimum is reached wherein ordinary influences (storage, environment) have no further effect. In some instances, varietal positions are maintained even after sharp reductions in vitamin C, *e g* Mohawk, Green Mountain, and Chippewa It is not universally true, however, that a variety high by virtue of its genes will be proportionately high when it reaches the consumer. The rapid loss of position by Sebago and slower gain in position by Green Mountain indicate that not only is maximum vitamin C expression a varietal trait but that the rate of response to deleterious factors is also a characteristic of variety.

Months. The largest losses occurred during the first month and became smaller thereafter. The values were practically stable during the last four months although a significant loss occurred in April of 1944 and in February of 1945

Temperatures. When both years' data are combined, 60° F. effected significantly higher retention of vitamin C than all other tested temperatures At the other extreme is 36° F, which was correlated with significantly low values The more favorable average shown by 32° over 36° was weighted by the anomalous high values of Mohawk at 32° F., apparent during both seasons. Fifty degrees showed second best retention and 70° and 65° third and fourth, respectively

When 1944-1945 data are considered separately it is seen that 50° was superior to all other temperatures in that season with only Mohawk showing significantly higher values at 32° F. In 1943 although 65° F. effects a slightly higher average retention, this does not differ significantly from 50° or 70° F.

The advantage attributed to 60° F. when two years' data are analyzed together is caused by the necessity of separate statistical treatment of the values at 60° and 65° F. This gave 60° F. the benefit of the 1944 environmental conditions favorable to high values. When each year's results are examined separately, 50° F. is seen to be as propitious as the higher temperatures for maintenance of vitamin C.

Comments

In view of the prominent position that potatoes occupy in the national dietary, even a small economy of the vitamin C would provide substantial nutritional profits to large numbers of consumers

A choice of varieties genetically superior in this characteristic is a logical beginning for the achievement of this design. Subsequent points of attack would involve conservation of the innate quantity during storage, shipping, and processing, which is complicated by a varietal difference in response to devaluating factors That original high value would remain relatively so after subjection to destructive agencies would be a natural assumption This was found to be true with four varieties of tomatoes, each of which remained in its relative position even under adverse environmental conditions (14). Other tomato varieties, however, have shown different rates of diminution during processing (10). Similarly the potatoes reported herein are seen to respond at different rates to storage temperatures and, in some cases, the superiority coincident with variety was rendered ineffectual. For those crops which are usually stored or processed before consumption, it would appear necessary to determine the rate of loss in storage and processing before classifying a variety as nutritionally superior.

It appears from the results of this study that storage at 50° F results in comparatively high vitamin C retention (at least up to the end of five months) and that little added benefit is derived by increased temperature. This is the highest degree tested which resulted in tubers of good quality Of those stored at 32°, Katahdin, Chippewa, and Mohawk became severely affected with internal mahogany browning and the other varieties with analogous symptoms of cold injury.[2] At the sixth

[2]Acknowledgment is accorded to D. Folsom, R. Bonde, and M. Hilborn for diagnosing potato diseases.

and seventh months, all of the varieties at 60°, 65°, and 70° F. revealed physiological breakdown after removal from storage. In some cases, this was manifested as a faint gray line at the edge of the vascular tissue. In severe cases, the blackening spread throughout the tubers.

Although more palatable potatoes result from storage at 50° F., excessive shrinkage and early sprouting ensue after 12 to 14 weeks at this temperature (4). Observations on weight loss made in connection with the present study indicate that varieties do not consistently follow this pattern. The figures were based on weights of only six tubers from each variety at each temperature but significant differences in weight loss between 36° and 50° F. did not occur until after four months' storage. At 50°, sprouting was noted after four months in all varieties except Mohawk, with Green Mountain showing barely visible sprouts. These two varieties seemed to preserve tissue firmness longer, whereas Sebago lost more weight and became objectionably shrunken much sooner than the other varieties. These observations may not hold true with larger numbers of samples or with other varieties. The weight losses noted are considerably larger than those presented by Stuart, Lombard, and Peabody (22) for Cobbler and Green Mountain at 32° F. with samples varying from one to three barrels.

It is not suggested that potato storage at 50° F. would be preferable to 40° F.—the recommended temperature It is only pointed out that significantly larger amounts of vitamin C are present after storage at this temperature than at 36° F. It is rather to be desired that methods could be developed to avoid the large vitamin C losses which occur in the early months of storage at all of the temperatures studied including 50° F

Summary

Six varieties of recently dug potatoes, Irish Cobbler, Mohawk, Green Mountain, Chippewa, Katahdin, and Sebago, were held at five temperatures, 32°, 36°, 50°, 60° or 65°, and 70° F. for a period of seven months in two successive seasons The tubers were analyzed for vitamin C at monthly intervals during the storage periods

The two years' analytic data were combined and reduced by the variance method which demonstrated significant varietal differences. Mohawk exhibited the highest average value and Chippewa the lowest of the varieties tested An average decrease from 22.7 mg. to 6.3 mg. per 100 grams took place during the seven months One-third to one-half of the total loss occurred during the first month.

The higher temperatures of 50°, 60° or 65°, and 70° F. were con-

ducive to larger retention of vitamin C than 32° and 36° F. Over the whole period, it was apparent that neither 60°, 65°, nor 70° is superior to 50° F.

There appeared to be a difference in varietal response to temperature and duration of storage. During both years Mohawk remained at a relatively high level and Chippewa at a low one throughout the entire period. Sebago decreased at a disproportionately rapid rate, whereas Green Mountain tended to improve its position. In general, varietal differences diminished greatly under the influence of storage but were not completely nullified.

The effect of storage on varietal differences was paralleled by its effect on seasonal variation. The new tubers averaged 10.9 mg. higher in 1944 than in 1943 After seven months' storage, the average difference was only 2 3 mg. per 100 grams.

Of the temperatures studied, only 36° and 50° F. maintained tubers of good physical quality. If vitamin C retention is a criterion of quality, 50° F. would be considered superior to all others tested.

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SUSCEPTIBILITY OF GREEN MOUNTAIN AND IRISH COBBLER COMMERCIAL STRAINS TO STEM-END BROWNING

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Stem-end browning is a type of internal discoloration of the xylem, phloem and adjacent parenchyma cells in the stem-end region of the potato tuber (10). In Maine it is largely restricted to the Green Mountain and Irish Cobbler varieties. The discoloration develops in storage, appreciable quantities seldom are found at digging time. The cause of the disease is unknown but the severity of the disease has been found to be affected by several factors, including fertilizer treatment (1, 3, 4, 6), storage temperature (7, 8, 9, 13), date of harvest (5), and date of planting (12).

FIGURE 1 Stem-end browning in Green Mountain tubers (Photographed by M T. Hilborn.)

Folsom and Rich (10) could find no evidence that stem-end browning is propagated in the seed, or that it is affected by origin of commercial strain Gussow (11) recommended the elimination from seed stocks of all tubers showing the disease, thus implying that it is propa-

[1]Biochemist, Maine Agricultural Experiment Station The author is indebed to Mr Michael Goven for most of the stem-end browning readings and to Dr J. A Chucka and Dr Arthur Hawkins for the data in table 8.

gated in the seed No data are presented, however, to justify this recommendation.

Since the publication of the paper by Folsom and Rich, it has been found by Folsom and associates that the temperatures at which the potatoes are stored have a profound influence on the development of the disease (7, 8, 9, 13). The optimum temperature was found to be about 50° F. and at this temperature a storage period of 90 to 100 days is required for maximum development. As these facts were not known when the earlier experiments were conducted and the optimum conditions were not used, the results in those experiments are inconclusive. Hence the questions of the possible propagation of the disease in the seed and the effect of source of seed on the disease have been reinvestigated. It is the purpose of this report to present results which show that stem-end browning is definitely related to the source of seed and that the differences in susceptibility among lots are propagated in the seed and are not caused by environmental conditions.

Unless otherwise stated the experiments here reported were conducted with the Green Mountain variety on Aroostook Farm, an experimental farm located near Presque Isle, in Aroostook County, Maine. All the tubers were stored at 50° F. for 90 days or longer before they were examined for the disease. Stem-end browning was differentiated from net necrosis by the objective method suggested by Folsom and Rich (10). The term "strain" is used with reservations. It is used to differentiate between different growers' stocks and does not necessarily imply genetic differences

Seed Tubers with Stem-End Browning *vs.* Normal Seed Tubers Selected from the Same Lot

A given lot of seed potatoes was examined for internal discoloration and the tubers divided into two portions, those showing typical stem-end browning and those normal in appearance. These two types from the same original lot were planted in the usual manner, either in adjacent rows or in randomized plots. From 4 to 20 paired bushel samples were taken from each lot at the time of digging It is apparent from table 1 that in most cases the crop produced from the seed showing the disease produced no more stem-end browning than that grown from normal tubers. In the case of a few lots, an appreciable difference was obtained but with the exception of lot No. 1 the results were not consistent from one field to another. A replanting of the above lots gave further evidence that except for lot No. 1 normal seed tubers

TABLE 1—*Comparison within lots of normal seed tubers with those showing stem-end browning*

Variety	Lot No.	Field No	Stem-end Browning[1] in Crop Produced from: Stem-end Browning Seed	Stem-end Browning[1] in Crop Produced from: Normal Seed	Yield: Stem-end Browning Seed	Yield: Normal Seed
			Per cent	Per cent	Bu./A	Bu./A.
Green Mt	1	1	15.3[2]	7.4[2]		
" "		2	10.8	6.9		
" "	2	3	62.8	55.4	429	437
" "	3	4	48.7	52.3	357	356
" "		5	41.5[2]	24.4[2]		
" "	4	6	22.4	22.1	456	451
" "	5	5	32.4	30.9		
" "	6	7	45.4[2]	30.4[2]	463[2]	567[2]
" "		6	12.9	15.5		
" "	7	5	32.9	30.8		
" "	8	5	32.2	30.9		
" "		8	20.3	21.4		
" "	9	9	9.4	8.3		
" "	10	9	15.0	16.7		
" "	11	9	35.5	28.4		
I Cobbler	12	10	18.3	16.9	442	436
" "	13	11	14.3	15.0	488	489

[1]The figures in these columns represent the percentage of the tubers showing stem-end browning and are the averages of 4 or more one-bushel samples. Readings were taken after 90 or more days' storage at 50° F

[2]Difference significant at 5 per cent level when analyzed by "Student's" method for paired samples

produced just as much stem-end browning in the stored crop as did seed tubers showing the disease. It was subsequently found that lot No. 1 was a mixture of commercial strains and all that was accomplished was a partial separation of resistant and susceptible strains. As far as the practical grower is concerned, little if anything can be gained by discarding seed tubers showing stem-end browning as suggested by Gussow (11)

The data on yield agree with those of Folsom and Rich (10) in that in most cases the two types of seed produced equally well. The single exception (Lot 6, field 7) was traced directly to a higher percentage of emergence in the case of the normal seed. The cause of poor emergence in the case of the stem-end browning tubers is unknown The fact that in this case the tuber symptoms were unusually severe, may have made conditions favorable for the entry and multiplication of microörganisms causing seed-piece rot.

Differences among Lots

In the early experiments it was noted that when different lots were planted on the same field, some lots consistently produced more stem-end browning than others Tests were made to determine whether these differences were caused by past handling of the lots used for seed or to inherited factors

Since stem-end browning develops in storage at 50° F. and not at 36° F (7, 8, 9, 13) it was thought possible that seed stored at the higher temperature might produce more stem-end browning than seed stored at the lower temperature Several lots of seed were divided into two portions, one stored at 36° F until shortly before planting; and the other stored at 50° for approximately 100 days, then shifted to 36° until just prior to planting These lots were then planted on randomized plots and the amount of stem-end browning in the crop determined after appropriate storage The data in table 2 indicate that the temperature at which the seed is stored has no appreciable effect on the amount of stem-end browning in the subsequent crop In other words, inhibition of stem-end browning by low temperature storage has no effect on the amount of stem-end browning in the crop produced from that seed.

TABLE 2—*The effect of storage temperature for the seed on the amount of stem-end browning in the crop*

Field	Type of Seed Used			Stem-end Browning in Crop[2]
	Lot[1]	Storage Temperature	Stem-end Browning in Seed	
		°F.	Per cent	Per cent
	A	36	Trace	44 7
1		50	47 4	44 2
	I	36	Trace	22 5
		50	11 3	17 2
	A	36	Trace	19 0
2		50	47 4	22 0
	R	36	Trace	6 7
		50	3 0	5 6
	BF	36	1 8	5 5
3		50	12 2	6 8
4	XVI	36	—	47 1
		50	—	39 0

[1]Lot 16 was Irish Cobblers All others were Green Mountains.
[2]The figures in this column are the weighted averages of 8 replicates,—each 29 ft long.

Inasmuch as some of the lots used for seed were early harvested and others late harvested, it appeared possible that this fact might possibly account for the differences noted. In 1941 samples were taken from a field of Green Mountains on 6 different dates, approximately two weeks apart. Sampling was such that the lots were as nearly alike as practicable except for date of digging. The six lots were planted in 1942 in randomized blocks and the crop examined for stem-end browning after storage at 50° F for 100 or more days. The data are given in table 3 and give no indication that the date of digging of the seed has any effect on the amount of stem-end browning in the subsequent crop.

TABLE 3—*The effect of maturity of Green Mountain seed on the amount of stem-end browning produced by that seed*

Description of Seed		Stem-end Browning in Crop[2]
Harvest Date	Stem-end Browning[1]	
	Per cent	Per cent
August 11	7.5	6.9
August 26	9.8	6.4
September 8	9.8	5.6
September 24	12.0	7.7
October 8	18.7	4.7
October 22	15.1	5.4

[1]The author is indebted to Dr. J. A. Chucka and Dr. A. Hawkins for the data in this column and for the seed used in this experiment. The stem-end browning readings were made after the potatoes had been stored at 50° F. for 100 or more days.

[2]The figures in this column are the weighted averages of 16 replicates,—each 29 ft. long. Stem-end browning readings were made after the potatoes had been stored at 50° F. for 100 or more days.

Other experiments gave no evidence that the size of the mother tuber had any effect on the amount of the disease produced. It was further found that the ordinary seed treatments, such as corrosive sublimate, had no effect on the amount of disease in the crop.

Records have now been kept on different lots for several years and, in all cases, the comparative behavior of each lot tested has been consistent from year to year and from field to field. Data collected over a 5-year period are summarized in table 4. Although there was consider-

able variation from field to field in any given y... ... cases the Keswick strain produced considerably more stem-end browning than did any of the other three. These, the Vermont and Highmoor strains and the Minnesota lot, were quite similar to each other in behavior

TABLE 4—*Comparison of four Green Mountain strains*

Year	Field	Stem-end Browning[1]			
		Keswick Strain	Highmoor Strain	Minnesota Lot	Vermont Strain
		Per cent	Per cent	Per cent	Per cent
1941	1	22.3	4.2		
1942	2	18.5		3.8	
	3	18.5	8.0	7.0	
	4	21.0	11.3	6.7	
	5	22.3	8.8	6.7	
	6	26.3		4.0	
	7	37.8			15.5
	8	38.6		16.1	14.3
	9	47.7	7.3	3.0	
1943	10	15.5	0.0	2.1	
	11	19.4		7.3	
	12	22.7		6.3	
	13	23.8		4.7	
	14	26.3		9.1	
	15	26.7		2.8	
	16	44.5	19.5	22.4	
1944	17	26.3	6.3		
	18	30.9		6.1	7.5
	19	32.7		9.7	
	20	36.3	5.4	8.7	7.7
	21	36.5		8.2	
	22	36.6		9.4	
	23	39.3		13.8	
	24	51.6		13.6	
	25	52.9		15.4	
1945	26	34.0	9.9	9.4	6.0
	27	31.6	9.1	7.2	

[1]The figures in these columns are the averages of 5 or more replicates,—each about 1 bushel in size. All samples were stored at 50° F. for 100 days or more before they were examined. Most of the fields were planted either in the Latin Square or Randomized Block design.

During the course of the work several lots were obtained from different areas and tested for susceptibility to stem-end browning in Maine. The relative behavior of these lots is indicated in table 5. There is no reason to believe that the behavior of the lots tested is typical of

the general behavior of lots in each area. The number of samples from each area is small and the lots were not necessarily selected at random. However, the data do indicate that both resistant and susceptible Green Mountain lots may be found in the same general area In fact, two lots obtained from a single grower were not alike; one was highly susceptible, the other resistant.

The lots tested were not necessarily different strains; in fact it is known that in many cases there was duplication of strains As far as the 4 susceptible Green Mountain lots found in Maine are concrned, it appears fairly certain that they are all of the same strain, namely the Keswick. As this particular strain has been widely distributed in the Northeastern States and in Eastern Canada, it appears probable that it alone is highly susceptible to the disease and that other strains are more resistant.

All of the Cobbler lots tested were equally susceptible and the degree of susceptibility was approximately the same as that in the Keswick strain of Green Mountains.

Tuber Line Selections

Examination of single hills revealed the fact that in most lots some hills were entirely free from stem-end browning whereas others had a varying percentage of the tubers showing the disease Likewise in fields planted by tuber units, some units would be free from the disease, whereas others would show varying amounts. The question arose as to whether or not the progeny of such units would differ in the same manner. Consequently several of the lots listed in table 5 were used as parent stock for tuber line selection for resistance to stem-end browning. Progeny of each tuber line was propagated 3 or 4 years and records were kept on the amount of stem-end browning produced by each Each tuber line was split, one half was planted and harvested under conditions similar to ordinary commercial practice for table stock and the other half was planted early on an isolated plot and early harvested Very little spread of leafroll or other common virus diseases occurred on the latter type, hence the crop from the early harvested plot was used for the next year's seed.

In table 6 data are presented on the distribution of stem-end browning in the original lots and notes on the general behavior of tuber lines drawn from each lot. It can be noted that in those lots highly susceptible to stem-end browning, very few units were free from the disease and a high proportion showed more than 50 per cent of the tubers with

TABLE 5—*Relative susceptibility of potatoes from different areas to stem-end browning*

Variety	Source	No Lots Tested	Number of Lots Showing the Following Relative Amounts of Stem-end Browning		
			High	Intermediate	Low
Green Mountain	Maine	16	4	2	10
	Vermont	2	1	—	1
	New York	1	—	1	—
	Minnesota	3	—	—	3
	Prince Edward I.	4	—	2	2
	New Brunswick	5	3	—	2
Cobblers	Maine	7	7	—	—
	Minnesota	1	1	—	—
	Wyoming	1	1	—	—
	Nebraska	3	3	—	

stem-end browning. Subsequent propagation of the progeny of tuber lines from such lots indicated that all tuber lines drawn from these lots were highly susceptible and, furthermore, all were equally susceptible

On the other hand, most of the lots low in stem-end browning showed a fairly high proportion of the tuber units free from stem-end browning and very few or no units with 50 per cent of the tubers affected Continued propagation of tuber lines drawn from these lots showed that all were identical in being resistant to stem-end browning. Hence nothing was accomplished by selection within these lots.

There were some lots, however, where selection of tuber lines resulted in the separation of susceptible and resistant lines For the most part, these lots showed intermediate amounts of stem-end browning in 1942. The susceptible lines selected from these lines were identical in susceptibility to such lots as A, J, D, and H whereas the resistant tuber lines were equal in resistance to that of such lots as F, X, and R. In tracing back the origin of these lots which appeared to be mixed tuber lines, evidence was obtained that at least some of them were mixtures of strains.

The tuber lines listed in table 7 were propagated 3 years in Maine Numbers 4 and 651 maintained a high degree of susceptibility for those 3 years and numbers 625 and 803 continued to be resistant. A com-

TABLE 6—*Distribution of stem-end browning in tuber lines and the general behavior of the progeny of those tuber lines*

Lot	1942[1]				1943-44
	Stem-end Browning in 1942		Proportion of Tuber Lines Showing		General Behavior of Tuber Line Selection[2]
	In all Tuber Lines	In Those Showing Some	No Stem-end Browning	50 Per cent Stem-end Browning or over	
	Per cent	Per cent	Per cent	Per cent	
A	47.4	48.3	2.5	62.5	All high
J	45.0	45.0	0.0	36.8	All high
D	43.6	43.6	0.0	43.0	All high
H	43.5	43.5	0.0	30.0	All high
L	35.0	38.6	6.0	21.0	Mostly high, some low
T	17.7	19.3	10.0	5.0	Mostly low, some high
N	17.2	18.4	6.0	0.0	Mostly low, some high
M	17.0	18.0	6.0	3.0	All low
G	16.7	18.8	10.0	0.0	Mostly low, some high
B	16.7	16.7	0.0	2.0	All low
S	16.5	17.5	6.0	4.5	Mostly low, some high
K	13.7	15.7	16.0	0.0	All low
Q	11.5	13.5	17.5	0.0	All low
I	11.3	12.5	13.8	0.0	All low
F	7.2	9.9	15.8	0.0	All low
X	5.1	7.9	35.0	0.0	All low
R	3.0	7.0	57.0	0.0	All low

[1]The different lots were not perfectly randomized in 1942, hence small differences are probably not significant
[2]The terms "high" and "low" refer to susceptibility to stem-end browning

parison of their behavior in respect to typical field run samples of the Keswick strain and the Minnesota lot was made the third year.

TABLE 7—*Comparison of tuber lines with the original parent lots*

Tuber Line	Description[1]	Stem-end Browning[2]
		Per cent
4	Susceptible	44 3
651	Susceptible	40 5
Keswick	Not selected	36.5
625	Resistant	11.5
803	Resistant	10 1
Minnesota	Not selected	8 2

[1]Tuber lines 4 and 651 were selected for high susceptibility to stem-end browning. Lots 625 and 803 were selected for resistance. The Keswick strain and Minnesota lot were used as controls, typifying unselected susceptible and resistant lots respectively

[2]The figures in this column are the weighted averages of 8 single row plots,—each 29 ft. long, from an 8x8 Latin Square.

In all cases the selections produced slightly more stem-end browning than did the field-run material The differences are probably not significant but, in any event, the resistant selections were no more resistant than the unselected Minnesota lot.

The evidence shows that in all Green Mountains tested, two and only two levels of susceptibility to stem-end browning exist. Most commercial lots belong to one class or to the other but some lots are mixtures It is only in this last-named group that the practice of discarding seed tubers showing the disease would accomplish anything. In view of the failure of some susceptible tubers to show the disease, the practice would at best eliminate the susceptible tubers very slowly. It would be much better to discard that particular lot and obtain a strain known to be resistant.

Several tuber line selections were also made using the different lots of Cobblers as parent material. In all cases the tuber lines were identical in susceptibility.

FACTORS INFLUENCING THE RELATIVE AMOUNTS OF STEM-END BROWNING PRODUCED BY SUSCEPTIBLE AND RESISTANT STRAINS

The data in table 4 may appear to be at variance with the hypothesis that there are only two levels of susceptibility to stem-end browning. In some cases the susceptible strain produced about seven times as

TABLE 8—*The effect of fertilizer treatment on the relative amounts of stem-end browning produced by resistant and susceptible strains of Green Mountain*

Permanent Plots[1] — 1944

Rotation	Treatment		Stem-end Browning[2]		
	Formula	Rate per A	Highmoor	Keswick	Ratio Keswick/Highmoor
		Lbs.	Per cent	Per cent	
3-year	—	0	0 8	0 9	1 3
	4-8-8	1500	7 1	24 1	3.4
	4-8-8	2000	6 3	26 3	4 2
	4-8-8	2500	7 1	23 8	3 4
	4-8-8	3000	13 2	18 5	1 4
	0-8-8	2000	14 6	11 5	0 8
	2-8-8	2000	10 8	36.4	3 4
	4-8-8	2000	6 3	26 3	4 2
	6-8-8	2000	8 3	24 7	3 0
	4-0-8	2000	9 0	15 9	1 8
	4-4-8	2000	7 1	34 7	4 9
	4-8-8	2000	6 3	26 3	4 2
	4-12-8	2000	7 7	28 8	3 7
	4-8-0	2000	1 2	1.7	1 4
	4-8-4	2000	3 3	8 1	2 5
	4-8-8	2000	6.3	26 3	4 2
	4-8-10	2000	12 3	30 6	2 5
	4-8-12	2000	15 6	36 3	2 3
	4-8-8[3]	2000	6 3	10 9	1 7
Continuous cropping	4-8-8	2000	15 9	39 0	2 5
	4-8-8	2500	10 8	25.0	2 3
	4-8-10	2000	7 9	25 0	3 2
	4-8-8	2000+20T. Manure	13 1	32 1	2 5

[1]Each plot received the indicated treatment each year it was planted to potatoes since 1927. For a description see bulletin by Chucka, Hawkins and Brown (2).

[2]After storage at 50° F. for 100 days or longer

[3]Prepared from chemically pure salts containing no nutrient elements other than N, P, and K. All others were prepared from the usual commercial fertilizer ingredients.

much stem-end browning as did the resistant strains and in other cases the ratio was less than two. There are several factors that influence the actual amount of stem-end browning produced by a given strain, but it does not follow that any one factor affects both types of strain to the same degree. In 1944 the Keswick and Highmoor strains were planted on a series of Permanent Plots located on Aroostook Farm. The relative amounts of stem-end browning produced by the two strains on each of the several plots are listed in table 8. It is evident that the ratio of stem-end browning produced by the Keswick strain to that produced by the Highmoor strain varies considerably from plot to plot In general, the widest ratio was obtained on those plots obtaining the usual or recommended amounts of a well balanced fertilizer. A deficient or excess amount of any or all elements tended to decrease the ratio This appears to be in accord with the general observation that fields producing either very high or very low yields also gave a narrow ratio in comparison with the fields where yields were more nearly average

The date of planting and the date of digging also affect the ratio (table 9). In 1944 early planting and late digging tended to give a wide ratio. There was no discernible trend in 1945 Apparently seasonal factors or other environmental conditions also operated to determine the behavior of the strains listed in table 9. The chief conclusion to be drawn from tables 8 and 9 is that cultural practices and environmental conditions in general play an important role in determining the relative amounts of stem-end browning produced bv the two types of strains. It should further be noted that a relatively high stem-end browning content in a given lot does not necessarily indicate that the lot is of the Keswick type, nor does a relative low stem-end browning content indicate a resistant strain. Comparison of strains can only be made under identical conditions

Susceptibility to Net Necrosis

Most of the lots and many of the tuber lines tested for susceptibility to stem-end browning were also tested for susceptibility to net necrosis This was done by planting portions of each lot or tuber line in an exposure plot where alternate rows were planted with tubers infected with leafroll. Records were kept on the amount of net necrosis developed in 50° F. storage. The tubers from the exposure plot were replanted and the percentage spread of leafroll determined. Records kept over a period of 3 years indicated that all lots and tuber lines were equally susceptible to both leafroll and net necrosis This applies to both Green Mountains and Irish Cobblers

TABLE 9—*The effect of date of planting and date of harvest on the relative amounts of stem-end browning produced by resistant and susceptible strains of Green Mountain*

Year	Date of Planting	Date of Digging[2]	Stem-end Browning[1]		
			Susceptible Strain	Resistant Strain	Ratio Susceptible/Resistant
			Per cent	Per cent	
	May 16	Aug 23	15.1	7.4	2.0
		Sept 9	13.1	4.7	2.8
		Sept 24	32.7	9.7	3.4
1944	May 31	Aug 24	27.6	26.9	1.0
		Sept. 8	26.0	16.8	1.5
		Sept 24	50.3	19.5	2.6
	June 15	Aug. 24	38.5	25.3	1.5
		Sept 8	33.1	17.3	1.9
		Sept 24	46.5	28.3	1.6
	May 4	Aug 20	13.1	5.4	2.4
		Sept 5	9.3	2.9	3.2
		Sept 18	24.2	11.4	2.1
1945	May 21	Aug 20	18.9	5.0	3.8
		Sept 5	11.4	4.0	2.9
		Sept 18	14.2	11.0	1.3
	June 1	Aug 20	25.6	11.2	2.3
		Sept 5	9.1	5.8	1.6
		Sept 18	37.4	7.8	4.8
	June 12	Aug 20	33.3	10.4	3.2
		Sept 5	25.6	9.1	2.8
		Sept 18	37.2	9.9	3.8

[1]After storage at 50° F for 100 days or longer. Average of three 32 ft single rows in 1944 and of four 25 ft rows in 1945

[2]Actually the date when tops were killed either by pulling or by frost Potatoes were dug 1 to 10 days later

Commercial Strains

In all probability, commercial growers who have considerable stem-end browning in their Green Mountains, would benefit considerably by changing to a resistant strain. This step would not necessarily eliminate stem-end browning but would reduce the amount in their crop. As far as the growers in Maine (or growers obtaining seed in Maine and producing in an area where stem-end browning develops) are concerned, sufficient information is at hand to aid in the selection of a satisfactory strain. Most of the named commercial strains grown by Maine Foundation Seed Growers have been tested. In table 10 are

Table 10—*Comparison of commercial strains*

Lot No.	Probable Strain	Stem-end Browning[1]
		Per cent
1	Keswick	33.6
2	Keswick	21.5
3	Keswick	25.7
4	Highmoor	6.4
5	Highmoor	7.4
6	Vermont	9.7
7	Vermont	7.5
8	Phillips	8.5
9	Phillips	5.6
10	Minnesota[2]	7.4

[1]The figures in this column are the weighted averages of 5 or 6 single row plots,—each 29 ft. long.

[2]This lot is included for the sake of comparison Its origin is unknown, other than that it was obtained from a grower in Minnesota.

listed commercial strains commonly grown in this state together with the amount of stem-end browning produced when all were grown on the same plot This list does not necessarily include all of those grown in Maine but those listed are among the leading strains and should be easy to obtain. As stated previously, as far as it is known at present, the only commercial strain grown in this area that is highly susceptible to the disease is that known as Keswick If this particular strain could be eliminated, stem-end browning would become a much less serious problem.

A change in seed according to the above recommendations will not necessarily improve the situation for the presence of considerable stem-end browning in a given lot does not necessarily indicate that the lot is of the highly susceptible type. From the figures in tables 4 and 8

it is apparent that under some conditions the so-called resistant strains may show appreciable amounts of the disease For example, in 1943 on field No 19 this type of strain showed around 20 per cent of the tubers with the disease. The important point to consider is that on the same field the Keswick strain showed twice as much stem-end browning. Hence a grower will improve the situation by changing seed only if he is growing a susceptible strain in the first place. It is probable, however, that most growers having serious trouble with stem-end browning are using a susceptible strain.

Summary

Different lots of Green Mountains vary greatly in susceptibility to stem-end browning It was determined that these differences are inherited and are not due to differences in the way the seed had been handled (date of harvest, storage, etc.) The behavior of each lot is consistent from field to field and from year to year. The data that were obtained indicate that there are two and only two degrees of susceptibility in the Green Mountain. In general, the susceptible type or strain produced 2 to 7 times as much stem-end browning as the more resistant strains, depending upon environmental conditions Tuber lines selected from either type were no more or no less susceptible than the original unselected lot Only in the case of those lots which were mixtures of susceptible and resistant strains, did tubers showing the disease produce more stem-end browning when planted than those tubers normal in appearance selected from the same lot. All Irish Cobbler lots were highly susceptible and all were equally susceptible.

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SECTIONAL NOTES

ALABAMA

The Irish potato deal in South Alabama this season has been somewhat disappointing, although at this time it would appear that fair returns will be obtained by most of the growers The season has been quite unfavorable Unusually heavy rains in May leached out most of the fertilizer and caused the potatoes to have an unhealthy appearance.

The unusually heavy rains in May also were responsible for severe damage—from late blight—to the foliage in many fields. The yield was not reduced very much from blight because the crop was practically mature at the time the vines were affected.

With favorable weather, the shipments will terminate during the first ten days of June. Approximately 3800 cars will be shipped by the end of the season.

Market conditions have been only fair Prices began the season at $3.50 per hundred for potatoes of 1½" and above in size Prices for No. 1 potatoes have averaged from $2 00 to $2.50 to the growers at the shed. No 1B size potatoes have brought very little.

Imported labor has assisted in harvesting the crop. About 500 of the laborers were used in the South Alabama area.

The costs of producing and handling the potatoes have been high in comparison with the returns.

The growers have been plagued this year with railroad strikes, fer-

tilizer and material shortages, high labor prices, and poor weather conditions (June 1)—L. M. WARE AND FRANK GARRETT

CALIFORNIA

The Kern County potato "deal" is on the move. We are now shipping about 600 cars per day. Until the 19th of May we had shipped 6,979 cars by rail as compared with 3,226 cars in 1945 and only 3,063 cars by rail in 1944, on the same dates. This is expected to be Kern County's banner year in yield of potatoes per acre. In each of the areas of this county, whether the early or the late, the yields are expected to be well above any previous year.

White Rose still remains the principal crop with Calrose, Russets, Bliss Triumph, and a few Pontiacs coming in for a total of approximately 4 per cent of the acreage. The Calrose will probably increase materially in years to come and may make it possible to extend the marketing period to the first of August which will be an added advantage to the growers of Kern County At the present time it is the general feeling that by the end of this week the shipments will be heavy enough and the price low enough to cause the government to begin to accept some potatoes on the price support program basis

There is an active market this year for cull potatoes for the making of alcohol and for dehydrated potatoes. Some potatoes are being canned. This, however, is an exceedingly small item.

About 15 per cent of this year's crop is being handled in bulk, the potatoes being picked up in sacks then dumped into an elevator drawn by a tractor or a truck, the potatoes elevated into the truck and then hauled into the shed. The truck bed is then hoisted on one side and the potatoes are dumped into a large concrete vat filled with water, after which the potatoes are elevated, graded, sacked, and loaded. This is reducing costs and speeding up the operation of marketing the crop. (May 22)—M. A. LINDSAY,

GEORGIA

I believe we have a prospect of a better potato crop in the southern part of the state this year than has been the case for some time. Weather conditions have been favorable and the crop looks very well at present with prospects of higher than normal yield.

In northern Georgia the acreage is somewhat reduced. Then too our planting operations were retarded because of continued rains. There

has been a gradual increase,—from year to year,—in the use of certified seed in our state (June 3)—ELMO RAGSDALE.

IDAHO

Idaho has practically completed moving that which was, by far, the largest potato crop in the history of the state. Actual car lot shipments to date have been more than 41,000 cars, with many of these cars being 500-bag cars. It is estimated that the total shipments really represent in the neighborhood of 53,000 normal 360-bag cars.

Some dehydrators are still operating using Idaho potatoes but supplies will soon be exhausted.

The certified seed has been practically all sold as a result of the heavy demand that developed rather late Some acreage of abandoned sugar beets is being planted to potatoes and this probably has contributed to the demand for certified seed.

The planting of commercial potatoes is practically complete in eastern Idaho, but has been somewhat delayed by the dry weather which made it necessary for farmers to irrigate before planting. The rains following irrigation delayed the planting operations for a longer period. Planting in southern Idaho is now in full swing and the season is about normal insofar as time, weather, and soil conditions are concerned.

The early potato crop in western Idaho shows a considerable increase in the acreage of Pontiacs planted as compared with previous years and a corresponding decrease in the acreage of Bliss Triumph. Some poor stands have been reported as a result of the dry spring and the planting of the seed in dry soil. (June 3)—JOHN R. ROBERTSON.

INDIANA

The potato season in our state has advanced compared with previous years. We find that there isn't so much of a change in the acreage as in varieties We have a larger acreage of Red Warbas this year than ever before. At present we are also faced with the possibility of a late blight epidemic attacking the early potatoes and are warning our growers to be sure to apply control measures during the month of June, as the cool, wet weather has been rather favorable for blight development

In cooperation with our plant pathologists and entomologists, an extensive pest control experiment is being planned at the Muck Farm A more detailed account of this test will be given at a later date (May 21)—W B. WARD.

BIGGER POTATO CROPS POSSIBLE

If you control Tuber Flea Beetles and Potato Psyllids with Highly Effective Geigy DDT

IF YOU SPRAY, use GESAROL* AK 50, a 50% Geigy DDT composition.

IF YOU DUST, insist that GESAROL VD 50 be used in preparing the dust mixture you buy.

You can depend on Geigy GESAROLS — they are prepared by the *Originators of DDT Insecticides.*

TUBER FLEA BEETLES

Use 2 lbs. of GESAROL AK 50 per 100 gallons of water per acre, or a 3% DDT dust (made from Gesarol VD 50) at 35 lbs. per acre. Make four to six applications at about 10 day intervals starting when the first beetles appear. If you prefer, use a 5% DDT-sulphur dust applied at 20 lbs. per acre. Insist that Gesarol VD 50 be used in making up this preparation.

POTATO PSYLLIDS

Use GESAROL AK 50 at 2 lbs. per 100 gallons of water per acre, or the 5% DDT-sulphur dust at 20 lbs. per acre as in the case of tuber flea beetles. Make three or four applications at about 10 day intervals starting about the middle of July, or according to local spraying and dusting schedules.

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MAINE

Although there have been interruptions caused by climatic changes during the planting season, Aroostook is finishing up at its usual time. Ninety per cent of the potatoes will have been planted by the 1st of June.

Machinery is still a problem with many farmers although the supply of planters has been rather liberal. There is a definite shortage of tractors but by swapping work and changing neighbor cooperation, farmers are "getting by."

Aroostook farmers have been squeezed on fertilizer but companies, in general, have spread their supplies so that most are short only a few tons The acreage is about the same as last year (207,000 acres) apparently. Some feel that possibly 75,000 acres will be entered for seed certification,—which will be the largest in history. Most farmers are talking about using DDT, and it will be used generally several times during the year by a large share of Aroostook growers

If DDT does increase yields materially, the county may well face a serious storage problem in the fall. The AAA is concerned over this possibility and is urging the Department to have plans ready so that if a big crop is produced, there will be ways and means of looking after it at support prices. (May 29)—VERNE C BEVERLY

NEBRASKA

Planting time for the western main crop areas of Nebraska is rapidly approaching. During the past three seasons, a rainy period set in about the 5th and extended to the 10th of June, and running from one to almost three weeks, threw these schedules far back into the month of June This season, remembering such experiences, growers plan to start about the 5th of June in many instances, even though this is against the recommendation of entomologists and pathologists. The later plantings, that is, from the mid to the latter part of June, are usually less troubled with insects, and possess definitely better quality and are more disease-free.

In central and eastern Nebraska, where plantings are made the fore part of April, similar experiences dictated an extremely early planting. Furthermore, the weather during March and April was ideal over most of the central part of the state. On the night of the 10th of May, there was a snowstorm in the western part of the state,—accompanied by a heavy freeze that extended across the state The early potatoes, planted the 1st of April, were four to six inches high, and were cut to

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the ground. In a few instances, the damage has extended below the surface of the ground. However, in most cases, these fields are apparently recovering satisfactorily, although they have been delayed two to three weeks in their growth.

Conditions for planting in the western area are very good at this time Rains have, more or less, extended over most of the area, and the seed bed is in perfect condition In fact, there has been too much rain and also too much cool weather for other crops

The intention to plant was for some reduction in the commercial acreage, but the certified acreage indications are for a slight increase compared with that of last year More definite information in this respect will be available by the end of the month (June 4)—MARX F KOEHNKE

NEW JERSEY

Most of our New Jersey potato vines are now in full bloom and making rapid growth Cobblers, in general, have grown better than the Katahdins and the prospects for a good crop are very favorable. The continued heavy rains have leached some of the fertilizer salts away from the potato roots and the plants in many fields have become light green in color because of a lack of adequate nitrogen. It is impossible, at present, to estimate the loss in yield that this condition has caused, but it will undoubtedly result in lower yields than were anticipated a few weeks ago. Some low areas have been drowned out but losses from this cause are not important

Many growers are having difficulty in getting their cultivating and spraying or dusting done and a few have resorted to dusting with airplanes DDT is being used rather extensively and to date the growers are well-pleased with the results obtained.

Harvesting of Cobblers will probably begin to a limited extent during the first week in July,—with rather general harvesting by the middle of the month. (May 15)—J. C. CAMPBELL.

NEW YORK

The potato acreage on Long Island is about the same as in 1945. The crop has emerged to a good stand We have not only started to cultivate but we have also begun our spraying operations.

Since we have had ample moisture, the potato vines are growing rapidly Our ground was in better condition than usual throughout the planting season

The varieties planted this season are as follows Cobblers, 45 per

cent; Green Mountains, 44; Chippewas, 9; and all others 2 per cent.

This shows a reduction in the percentage of Green Mountains of about 8 per cent,—which is due to the fact that Green Mountains are not keeping so well as formerly.

On our own farm,—for the past nine years,—under irrigation, we have found that no varieties yield better than do the Cobblers for the early, and Green Mountains for the late crop. We are trying all the new varieties, but to date we have found none of good eating quality, which at the same time yield well under Long Island conditions (May 27)—HENRY R. TALMAGE.

OREGON

Our potato operations are practically complete, (June 1) It looks as if our acreage will be reduced about 10 per cent below the 28,000 acres planted in 1945. The weather has been favorable for farm work and planting, although it has been extremely dry. A heavy rain on the 20th of May following a 60-day drought, greatly improved the situation on both the dry and the irrigated lands Lack of demand for certified Russets this spring may reduce the amount to be certified this year However, there is an increased interest in certified White Rose Klamath County and state are planning increased control work this year,—particularly as regards virus diseases

Shipments, both commercial and seed stock were practically completed by the 20th of May Local carlot shipments from Klamath District amounted to 12,000. Our growers are considering the establishment of a cooperative starch-glucose manufacturing plant. (May 21)—A. H. HENDERSON.

SOUTH CAROLINA

The 1946 potato crop in this state attained an all-time record average yield. Many growers are reporting averages of 175 to more than 200 bags per acre The entire state will not average such high figures, but the prediction is for an average above last year's record crop.

The crop began to move to market on the 1st of May, but heavy movement was confined to the period between the 13th and the 21st. The deal is closing at this time. Harvesting and marketing have proceeded under extreme difficulties Frequent showers have delayed digging and the rail strike has caused considerable loss and delay in shipment.

Our prices ranged from $2.25 to $3.00 until the last 10 days, when most shipments went to the government at $2.10. Carolina growers had

expected to make a nice profit on this year's excellent crop, but will have to be content with only a small profit because of marketing problems.

Except for soft rot resulting from excessive rains the crop was of good quality Late blight first occurred the day digging began It quickly increased to epidemic proportions which was not unwelcome as it killed vines so that digging could proceed There was entirely too much black leg in some lots of certified seed and one lot contained ring rot. The percentage of virus in certain lots of seed was higher than desired but not alarmingly high (June 6)—W. C. Barnes.

SOUTH DAKOTA

Early-planted potatoes are now up and some cultivation has taken place. Our stands are good despite the fact that some frost damage was reported on the night of the 1st of June. Moisture conditions are excellent at this writing (June 3). The acreage to be entered for certification this year will probably be about the same as last year,—at which time 9,000 acres were entered

The annual potato tour will again be held about the 15th of July. (June 3)—John Noonan.

WASHINGTON

The season in Washington has been unusually cold and rainy We have not had excessive rainfall, but it has continued over so long a period that it has kept the ground continually wet and made it impossible to cultivate except in the lighter soils. This has resulted in a delay of planting. However, we have had about three weeks during the latter part of May of sudden warm, dry weather. The result has been—rather unfavorable growing conditions for not only potatoes but for several other crops as well.

Grasses have thrived, of course, but the crops requiring plowing and cultivation have necessarily been planted late. Our seed potato planting was completed last week. The acreage for 1946 seems to be about normal. Vegetable seed crops have been curtailed to a considerable extent,—owing largely to the sudden closing of the war with the result that the government quit buying seed and has left a surplus of many vegetable seeds on hand among the various agencies who have contracted for the growing of these seeds. Many of the seeds have now been sold which will probably result in an increased vegetable seed acreage for 1947 production. (June 3)—Chas. D Gaines

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RESISTANCE OF POTATO SEEDLING VARIETIES TO THE NATURAL SPREAD OF LEAF ROLL

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AND

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INTRODUCTION

Virus leaf roll is one of the more important diseases of the potato (*Solanum tuberosum* L) in Maine and in some potato areas outside of Maine It causes economic losses in Maine by reducing yields, by causing net necrosis in the tubers of some varieties, and by increasing the cost of production of certified seed for use in other states The practices recommended for the control of leaf roll, such as the growing of special seed plots, the testing of seed stock in Florida during the winter months, and the use of certified seed, have succeeded in holding the disease in check in Maine, but frequently epidemics occur that result in heavy losses to the industry

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[1]Head of Department of Plant Pathology
[2]Principal Geneticist.

Varieties differ in susceptibility to the natural spread of leaf roll in the field, and in their reactions to infection Some varieties, such as the Katahdin, are moderately resistant in the field, and the tubers do not develop net necrosis; others, such as Chippewa, are quite susceptible but, as in the Katahdin, the tubers do not develop net necrosis as a symptom Varieties such as Green Mountain, on the other hand, are susceptible to infection in the field and frequently a high percentage of the tubers develop net necrosis (25).

Recently efforts have been made to solve the leaf roll problem by breeding—with varying degrees of success. A number of foreign varieties have been introduced which were reputed to show a higher degree of resistance than any of the American sorts (31) and attempts are being made to combine this higher type of resistance with the desirable characters of American commercial varieties.

Methods

In 1925, Schultz and Folsom (26, p. 102; 27, p. 524) showed that leaf roll spreads more readily in southwestern Maine than in Aroostook County in northeastern Maine Other observations and experiments have since confirmed this correlation (10, 11) In 1938, therefore, Highmoor Farm near Monmouth in southwestern Maine was chosen as a place for testing new seedling varieties with the first aim to learn whether or not any crosses would furnish seedlings field-resistant to leaf roll If this proved to be the case, a second aim was to increase any new commercially desirable resistant seedling so as to make it available for use by potato growers, and a third aim was to use resistant seedlings as parents in new crosses designed to combine leaf roll resistance with commercial desirability and with resistance to ring rot and other diseases

In general the Highmoor Farm method of testing for leaf roll resistance is as follows Every third row is of leaf roll Chippewas, which die early, thus encouraging aphid dispersal The other rows are seedlings or healthy check rows of the Green Mountain and Chippewa varieties Each seedling is introduced in the Highmoor Farm test field as a single tuber from a plant grown from true seed at Beltsville, Maryland, in the greenhouse where spindle tuber and rugose mosaic are kept out better than is the case with field test plots In all the work, every tuber is planted whole; this saves time and space and there is no apparent advantage from using tuber units in this work. Of the tubers produced by the single plant of the first year of

exposure, all are kept and planted the second year, if there are no more than ten; otherwise the ten largest are kept and planted From the crop of the second year of exposure, the ten largest tubers are kept. From the crop of the third year of exposure, the 20 largest tubers are kept The largest tubers are most likely to have leaf roll and they produce large plants quickly. Up to this stage in the process, if a single tuber of a seedling produces a leaf roll plant in any year, the seedling is discarded immediately. Until recent years, most of the new seedlings have been discarded at or before this stage because of leaf roll Some seedlings are discarded also for obvious commercially undesirable characteristics of vines or tubers, even if they do not have leaf roll, in order to make room for as many new seedlings as possible each year From the crop of the fourth year of exposure, the 50 largest tubers are kept Thereafter, 100 tubers are kept each year In the 50-hill or 100-hill stage, some tolerance is allowed for leaf roll, but over 10 per cent is cause for discarding unless the seedling is one that has some promise commercially or as a generally desirable parent for further crosses Some apparently commercially desirable and some apparently leaf roll-resistant seedlings from other test plots were included at first but the practice proved undesirable on account of the rugose mosaic and spindle tuber thus brought in At Beltsville the cross is made in winter, the seeds are planted in summer in the greenhouse, and the first tubers are harvested in the fall and planted the next spring at Highmoor Farm

General Results

In the seven years 1938 to 1944 inclusive, 10,708 seedlings from 105 crosses were introduced into the leaf roll test at Highmoor Farm. The residue by annual batches by the end of the growing season of 1945 is shown in table 1 It is apparent from the data in table 1 that usually a great majority of the seedlings have contracted leaf roll in the year of their inclusion in the test, and that exposure for two years or more has eliminated nearly all of every annual introduction At the end of the growing season of 1945, only 406 seedlings remained as leaf roll resistant, and these represented only 26 crosses of the 111 involved

Sources of Resistance to Leaf Roll

At first, various European and American commercial varieties were used as possible sources of leaf roll resistance in crosses, al-

though the European varieties are far from meeting U. S. tastes and requirements except for reputed resistance in some. Then resistant seedlings from these crosses were used for further crossing. The results of exposure to leaf roll at Aroostook Farm in 1937, a year of unusual spread there (3, p. 20), and at Highmoor Farm from 1938 to 1944, of various commercial varieties and of most of the resistant seedlings from the crosses introduced in 1939 and 1940, are given in table 2. Judging from the data in table 2 on the Green Mountains and some of the seedlings, 1941 and 1944 were the years of the most spread of the disease at Highmoor Farm. Even in those two years, many of the seedlings from cross B24, both seedlings from cross X247, and one seedling from cross X1276, were very resistant to leafroll. These three crosses were respectively Imperia x Earlaine, Kepplestone Kidney x Earlaine, and Houma x Katahdin. It may be seen from table 2 that Imperia and Kepplestone Kidney contracted no leaf roll in two years, that Houma contracted very little in three years, and that Katahdin contracted none in one year and much less than Green Mountain in another year. Thus the resistant seedlings listed in table 2 may be considered as owing their resistance to the use of resistant varieties as parents. Houma has been shown to be resistant to field infection in Maryland (31, p. 5) and to aphid infestation (1, p. 15). The resistance of the variety Imperia is confirmed by observations in Sweden (15, 16) and in France (30), and resistance

TABLE 1.—*Leaf roll elimination of seedlings in annual field tests.*

Year of introduction to field tests	1938	1939	1940	1941	1942	1943	1944
Crosses involved	14	30	13	20	10	11	10
Seedlings tested for the first time	776	1522	1120	2200	1273	1795	2022
Percentage of seedlings contracting leaf roll in first year of testing[1]	69	77	90	81	72	55	93
Percentage of healthy Green Mountains contracting leaf roll in first year of testing[1]		66	50	77	24	50	91
Percentage of healthy Chippewas contracting leaf roll in first year of testing[1]	49	.		90	89	77	93
Leaf roll-resistant seedlings remaining at end of 1945	0	11	3	1	4	277	110
Crosses represented by leaf roll-resistant seedlings remaining at end of 1945	0	3	1	1	2	11	9

[1]In Maine, practically all leaf roll contracted in one growing season remains undetected until the next generation is grown, unless net necrosis and spindling sprouts appear as symptoms.

TABLE 2.—*Susceptibility of certain commercial and seedling varieties to natural spread of leaf roll at Highmoor Farm*

Variety	Percentage of Leaf Roll Contracted by Healthy Hills[1]							
	1937[2]	1938	1939	1940	1941	1942	1943	1944
Albion	30							
Bevelander[3]	0	0						
Cardinal	30							
Chance	50							
Chippewa		49			90	89	77	93
Earlaine #2		21	35					
Friso	33							
Green Mountain			66	50	77	24	50	91
Harmony Beauty		12						100
Houma	7	3	25					
Imperia[3]	0	0						
Irish Cobbler		9	37					
Katahdin		0	25					
Kepplestone Kidney[4]	0	0						
Noordeling[3]	0	0						
Sebago	6	10	34					
Shamrock	0	15						
Triumf[3, 5]	0	2						
Warba		6	17					
White Rose[4]		5						
X247-30			0	0	0	1	3	
X247-48			0	0	0	1	0	9
X750-10			0	0	23	19	10	54
X1276-48			0	4	26	5	0	25
X1276-179			0	0	50			
X1276-185			0	0	6	1	0	0
B24-7				0	0	0	1	7
B24-9			0	0	4	1	2	6
B24-16				0	0	0	0	4
B24-19				0	0	2	0	36
B24-58			0	0	0	0	0	0
B24-76			0	0	4	0	1	6
B24-78			0	0	4	0	1	5
B24-91			0	0	2	1	0	0
B24-156			0	0	0		0	
B24-174			0	0	4	1	3	11
B24-190			0	0	6	4	0	16
B24-238			0	0	0	4	0	0
B24-304			0	0	2	7	0	
All new seedlings[6]		69	77	90	81	72	55	93

[1]In Maine, the percentage of a seed stock contracting leaf roll in one season can be judged only by the percentage appearing in the stock early the following season

[2]Exposure in 1937 was in Aroostook County, 1937 being a year of unusual spread there

[3]Discarded in 1939 on account of having spindle tuber.

[4]Discarded in 1939 on account of having mosaic

[5]Leaf roll doubtful.

[6]Total of new seedlings introduced was, respectively for the seven years, 776, 1522, 1120, 2200, 1273, 1795, and 2022 Percentage of leaf roll was based on total seedlings remaining after a minority had been eliminated by wet soil patches and by discarding for poor tuber form in year of introduction

has been observed for Kepplestone Kidney in Ireland (20) However, Salaman (24) considers Imperia to be a tolerant carrier of leaf roll, though submitting no evidence, while Murphy (20, p 1) states that a potato plant carrier of leaf roll is unknown. Earlaine, not tested at Highmoor Farm, may have contributed more or less to the resistance of the seedlings in question, because its pedigree goes back in part to Sutton Flourball (4), which may have been the same as the Flourball reported to be resistant to leaf roll in Ireland (17, 20) and England (23, p 256-7) and to be the parent of a resistant seedling in England (22, p. 86)

Certain seedlings among those listed in table 2 were considered to be resistant to the field spread of leaf roll and were soon used as parents in crosses, some of which were introduced into the Highmoor Farm test in 1943 The results of exposure to leaf roll in 1943 are given in table 3 These data show that on the whole the percentage of leaf roll contracted in 1943 was reduced by the use of none but resistant seedlings as parents (two seedlings crossed or one selfed) as against the use of a resistant seedling as one parent and a commercial variety as the other parent. Crosses of the former kind are represented by 597 seedlings of which 40 per cent contracted leaf roll, while crosses of the latter kind are represented by 931 seedlings of which 61 per cent contracted leaf roll This difference was not a matter of chance escaping inoculation, for two reasons First, there was a variation from 32 to 77 per cent, and this variation showed no relationship to the order of planting or the location in the four-acre test plot in 1943 Second, if it were a matter of escaping inoculaton by chance, the variation should even up in the percentages contracting leaf roll in 1944 As has been noted previously, 1944 was a year of more leaf roll spread than usual at Highmoor Farm In 1944 about half the seedlings that had remained healthy in 1943 contracted leaf roll, but there still was a difference in favor of crosses with both parents resistant seedlings as against crosses with one parent a commercial variety Further, the five crosses X247-48 x a commercial variety contracted respectively about the same amount of leaf roll in 1944 in the remaining healthy seedlings as they had in 1943 These facts indicate that crosses showed the same relative resistance in 1944 in healthy seedlings that had survived the 1943 exposure that they had shown in 1943 in the original introduction.

The seedlings introduced in 1944 were in part from crosses with one parent a Highmoor Faim leaf roll-resistant seedling and in part

from crosses in which some other variety, European or seedling, was supposed to supply factors for leaf roll resistance. The data are presented in table 4, and show that the former group of crosses produced 14 times as many seedlings not contracting leaf roll in 1944 as did the latter group of crosses Again, therefore, the use of proved leaf roll-resistant seedlings as parents increased the chances that the crosses would show resistance

A comparison of data in tables 2, 3, and 4 may now be made to

TABLE 3—*Influence on resistance to natural spread of leaf roll, of the use of resistant Highmoor Farm seedlings as parents in crosses introduced in field tests in 1943*

Cross	Total 1944[1]	Contracting Leaf roll 1943[2]	Total 1945[3]	Percentage of Those Not Contracting Leaf roll 1943 That Contracted Leaf roll 1944[2]	Severity of Leaf roll in Those Contracting the Disease in 1944[4]
		Per cent[5]		Per cent[6]	
B1097 X247-48 selfed	117	54	29	62	Light
B420 X1276-48 x X247-48[7]	223	35	131	50	Mostly heavy
B429 X1276-179 x X247-48	72	32	39	54	Moderate
B410 X750-10 x X247-48	149	42	68	34	Light
B1098 X750-10 selfed	36	33	17	88	Mostly heavy
B308 X247-48 x Sebago	223	74	47	77	Mostly heavy
B289 X247-48 x Katahdin	230	77	49	73	Mostly heavy
B285 X247-48 x Green Mountain	243	52	91	55	Mostly light
B314 X247-48 x Sequoia	68	44	34	41	All heavy
B298 X247-48 x Houma	139	37	74	34	Mostly heavy
B422 X1276-179 x Katahdin	28	57	10	40	Moderate
X247-48 x seedling, 4 crosses	561	40	267	48	
X247-48 x commercial variety, 5 crosses	903	61	295	56	
Seedling x seedling, 5 crosses	597	40	284	50	
Seedling x commercial variety, 6 crosses	931	61	305	56	

[1]After a minority had been eliminated by wet soil patches and by discarding for poor tuber form in 1943

[2]In Maine, the percentage of seed stock contracting leaf roll in one season can be judged only by the percentage appearing in the stock early the following season

[3]After a minority had been eliminated by wet soil patches and by discarding for poor tuber form in 1944, tuber form being judged less leniently than in 1943

[4]Severity of leaf roll here means the proportion of hills per diseased seedling, rather than degree of dwarfing

[5]Based on total 1944

[6]Based on total 1945

[7]The male parent is given first by the U S Department of Agriculture, who supplied all the crosses used in this study.

TABLE 4.—*Influence on resistance to natural spread of leaf roll, of the use of resistant Highmoor Farm seedlings as parents in crosses introduced in field tests in 1944*

Cross	Total 1945[1]	Contracting Leaf Roll 1944[2]	Not Contracting Leaf Roll 1944	Severity of Leaf Roll in Those Contracting the Disease 1944[3]
		Per cent[4]	Per cent[4]	
B455 Sebago x X247-48[5]	242	94	6	Mostly heavy, early
B484 B56-11 x X247-48	21	90	10	Not heavy
B514 X750-10 x 96-56	192	81	19	Mostly heavy
B510 X1276-48 x 96-28	134	99	1	Mostly heavy
B528 X1276-185 x 1241-91	134	66	34	Many heavy
B520 Ballydoon x 46952	137	99	1	All heavy
B526 Friso x Katahdin	171	99	1	All heavy
B501 Friso x 46952	221	98	2	All heavy
B502 Friso x 47102 (Teton)	228	100	0	All heavy
B453 245-25 x 1241-91	73	97	3	Many heavy
With one parent a resistant seedling, 5 crosses	723	86	14	
Other 5 crosses	830	99	1	

[1]After a minority had been eliminated by wet soil patches and by discarding for poor tuber form in 1944

[2]In Maine, the percentage of a seed stock contracting leaf roll in one season can be judged only by the percentage appearing in the stock early the following season

[3]Severity of leaf roll here means the proportion of hills per diseased seedling, rather than degree of dwarfing

[4]Based on total for 1945

[5]The male parent is given first by the U. S Department of Agriculture, who supplied all the crosses used in this study

bring out any correlation between resistance of particular parents and of resulting crosses Houma, X247-48, and X1276-185 were markedly more resistant than Friso, Sebago, X750-10, X1276-48, and X1276-179 The cross X247-48 x Houma was only half as susceptible in 1943 and 1944 as the cross X247-48 x Sebago, the crosses using Friso as a parent were very susceptible in 1944, and the cross using X1276-185 was exceptionally resistant in 1944 However, the crosses using X750-10, X1276-48, and X1276-179 were not notably less resistant on the whole than the crosses using X247-48, in 1943 and 1944 Apparently greater resistance in a parent often, but not always, means greater resistance in the resulting cross

As explained previously, in the first three years of testing at Highmoor Farm a single leaf roll tuber in a seedling unit has been considered sufficient cause for elimination The number of leaf roll tubers in susceptible seedlings varies from one to all Therefore, the

TABLE 5.—*Breeding value of varieties for leaf roll resistance as indicated at Highmoor Farm by end of the 1945 growing season*

Parent Evaluated	Other Parent	Test Begun: Year	Test Begun: No. of Seedlings	Years Duration[1]	Seedlings Left for 1946
Albion[2]	Earlaine	1939	200	3	.
Albion	Katahdin	1939	29	1	..
Albion	Richter's Jubel	1939	503	3	.
Albion	Earlaine	1940	194	2	..
Albion	Katahdin	1940	49	2	..
Albion	Ostragis	1940	260	2	
Ballydoon[2]	46952	1944	201		2
Bevelander[2]	Katahdin	1940	32	1	..
Bevelander	Katahdin	1941	8	1	.
Bevelander	Katahdin	1942	48	2	..
Bevelander	245-25	1942	11	1	..
Chance	Earlaine	1939	132	2	..
Chippewa	Chippewa[3]	1941	108	2	
Daber	Earlaine	1940	10	2	.
Dakota Red[2]	Earlaine No. 2	1942	369		5
Dakota Red	Katahdin	1942	24	2	.
Dakota Red	B127	1942	97	3	..
Dakota Red	447-4	1942	35	3	..
Dakota Red	918-12	1942	358		2
Earlaine	Albion	1939	200	3	..
Earlaine	Chance	1939	132	2	.
Earlaine	Imperia	1939	468		5[4]
Earlaine	Kepplestone Kidney	1939	53	..	2
Earlaine	Albion	1940	194	2	
Earlaine	Daber	1940	10	2	.
Earlaine	Imperia	1940	102	.	2[5]
Earlaine	Katahdin	1940	35	3	.
Earlaine	Sebago	1940	129	2	..
Earlaine	41956	1940	72	2	.
Earlaine	Sebago	1941	208		1
Earlaine No. 2	Dakota Red	1942	369		5
Friso[2 6]	Katahdin	1944	229	.	1
Friso	46952	1944	281		5
Friso	47102	1944	273	1	..
Green Mountain	X247-48	1943	261		36
Hindenburg[7]	Katahdin	1941	97	2	.
Houma[8]	Katahdin	1939	216		1
Houma	X247-48	1943	127		49
Imperia[2]	Earlaine	1939	468	.	5[4]
Imperia	Katahdin	1939	15	6	.
Imperia	Earlaine	1940	102		2[5]
Jersey Redskin	B127	1941	192	3	.
Katahdin	Albion	1939	29	1	
Katahdin	Houma	1939	216		1
Katahdin	Imperia	1939	15	6	.
Katahdin	Albion	1940	49	2	.
Katahdin	Bevelander	1940	32	1	..
Katahdin	Earlaine	1940	35	3	.
Katahdin	Katahdin[1]	1940	79	4	..
Katahdin	No Blight	1940	85	1	..
Katahdin	41956	1940	73	1	.

TABLE 5.—*Breeding value of varieties for leaf roll resistance as indicated at Highmoor Farm by end of the 1945 growing season (Continued)*

Parent Evaluated	Other Parent	Test Begun Year	Test Begun No. of Seedlings	Years Duration[1]	Seedlings Left for 1946
Katahdin	Bevelander	1941	8	1	
Katahdin	Hindenburg	1941	97	2	
Katahdin	Bevelander	1942	48	2	
Katahdin	Dakota Red	1942	24	2	
Katahdin	96-56	1942	141		1
Katahdin	X247-48	1943	266		13
Katahdin	X1276-179	1943	37		6
Katahdin	Friso	1944	229		1
Kepplestone Kidney[8]	Earlaine	1939	53		2
No Blight[9]	Katahdin	1940	85	1	
Ostragis[6]	Albion	1940	260	2	
Richter's Jubel[6]	Albion	1939	503	3	
Richter's Jubel	245-25	1941	170	2	
Richter's Jubel	528-170	1941	449	3	
Sebago	Earlaine	1940	129	2	
Sebago	Earlaine	1941	208		1
Sebago	Sebago[7]	1941	48	2	
Sebago	245-25	1941	169	3	
Sebago	X247-48	1943	264		11
Sebago	X247-48	1944	378		14
Sequoia	X247-48	1943	74		20
41956	Earlaine	1940	72	2	
41956[10, 11]	Katahdin	1940	73	1	
46952[5]	Ballydoon	1944	201		2
46952	Friso	1944	281		5
47102[5]	Friso	1944	273	1	
47156	47483	1941	21	3	
47483	47156	1941	21	3	
47562	47562[7]	1941	138	3	
B56-11[6]	X247-48	1944	38		2
96-28[9]	96-28[7]	1941	26	2	
96-28	X1276-48	1944	179		2
96-44[9]	96-44[3]	1941	28	2	
96-56[9]	96-56[3]	1941	31	2	
96-56	Katahdin	1942	141		1
96-56	X750-10	1944	260		36
96-99	96-99[3]	1941	11	2	
96-109	96-109[3]	1941	44	3	
96-140	96-140[3]	1941	32	2	
96-345[9]	96-345[3]	1941	43	2	
B127	Jersey Redskin	1941	192	3	
B127	B127[7]	1941	114		1[12]
B127	Dakota Red	1942	97	3	
X156-115	Unknown[13]	1942	96	2	
X156-136	Unknown[13]	1942	85	1	
245-25[6]	Richter's Jubel	1941	170	2	
245-25	Sebago	1941	169	3	
245-25	Bevelander	1942	11	1	
245-25	1241-91	1944	94		2

TABLE 5 —*Breeding value of varieties for leaf roll resistance as indicated at Highmoor Farm by end of the 1945 growing season* (*Continued*)

Parent Evaluated	Other Parent	Test Begun		Years Duration[1]	Seedlings Left for 1946
		Year	No of Seedlings		
X247-48[14]	Green Mountain	1943	261		36
X247-48	Houma	1943	127		49
X247-48	Katahdin	1943	266		13
X247-48	Sebago	1943	264		11
X247-48	Sequoia	1943	74		20
X247-48	X247-48[3]	1943	197		11
X247-48	X750-10	1943	181		45
X247-48	X1276-48	1943	252		66
X247-48	X1276-179	1943	80		18
X247-48	Sebago	1944	378		14
X247-48	B56-11	1944	38		2
447-4[9]	Dakota Red	1942	35	3	
528-170[6]	Richter's Jubel	1941	449	3	
X750-10[14]	X247-48	1943	181		45
X750-10	X750-10[3]	1943	56		2
X750-10	96-56	1944	260		36
918-12[9]	Dakota Red	1942	358		2
926-36[11]	926-36[3]	1941	263	3	
1241-91[3]	245-25	1944	94		2
1241-91	X1276-185	1944	184		46
X1276-48[14]	X247-48	1943	252		66
X1276-48	96-28	1944	179		2
X1276-179[14]	Katahdin	1943	37		6
X1276-179	X247-48	1943	80		18
X1276-185[14]	1241-91	1944	184	.	46

[1]"Years duration" means number of summers of exposure to leaf roll needed for elimination of all seedlings for susceptibility to leaf roll
[2]Reputedly resistant to leaf roll
[3]Selfed
[4]Nine others were leaf roll resistant until discarded
[5]One other was leaf roll resistant until discarded
[6]Reputedly resistant to ring rot
[7]Reputedly resistant to scab
[8]Reputedly resistant to aphids
[9]Reputedly resistant to late blight
[10]Immune to virus X.
[11]Resistant to virus A
[12]Discarded for spindle tuber.
[13]Natural pollination
[14]Resistant to leaf roll at Highmoor Farm in these tests

percentage of seedlings eliminated from a cross is higher than the percentage of total tubers with leaf roll This is evident from tables 3 and 4 For example, crosses B1097 and B285 with a fairly high percentage of seedlings eliminated had on the average a light (low-percentage) infection in the seedlings taking leaf roll in 1944, whereas

cross B528 with the highest percentage of healthy seedlings in 1945 was about as severely diseased as any other cross in the seedlings that had contracted leaf roll in 1944

The breeding value of fifty commercial and seedling varieties, in 67 crosses, for leaf roll resistance at Highmoor Farm is indicated in table 5 Most noteworthy is the poor performance of Bevelander, as a parent, although itself resistant (table 2). Albion and Chance, themselves not very resistant, also were poor parents judging from the rapid elimination, by leaf roll, of the crosses in which they were used Albion for example, was the parent of 1235 seedlings of which most were eliminated the second year after introduction, and all by the third year, or, in other words, by two or three years of exposure to leaf roll spread

Seasonal Variation in Leaf Roll Spread

The question may be considered as to the probable cause of 1941 and 1944 being years of unusual spread of leaf roll in the test Conditions of various kinds are listed in table 6 Rainfall, temperature, field location, and non-aphid insect populations were quite different for the two years The only way in which the two years were alike and yet were different from the other years of less leaf roll spread, was earliness of dying of the leaf roll rows, but aphids had already decreased to none or few before the tops died. Mention is made in table 6 of non-aphid insects Negative results in leaf roll transmission experiments were obtained with such insects at Highmoor Farm (10, p. 242-245, in Nebraska (14, p. 3, 10-11), in Oregon (7, p. 327-328), and in England (28), and those reporting positive results from Ireland (19) and Holland (8) have nevertheless maintained that *Myzus persicae* is by far the most important natural vector (20, p. 5; 8.) Possibly green peach or spinach aphids (*Myzus persicae*) were more abundant in the two years; they were present each year but no attempt to classify aphids by percentages of total population was possible in the time available It is also possible that aphid vectors dispersed from leaf roll to healthy plants earlier in the plants' development in 1941 and 1944, spinach aphids in controlled experiments in Ireland infected plants less completely as the plants' age at inoculation was greater (20, p 6-7), and fewer potato aphids (*Macrosiphum solanifolii* Ashm) at Highmoor Farm in 1930 in cages were required to infect small young late-planted potato plants than large old early-planted plants (10, p. 244)

Discussion

The preceding data show that it has been possible to find potato seedlings resistant to the natural spread of leaf roll from one row to the next in a certain location in southwestern Maine, provided the right crosses are used and many seedlings are introduced in the test Some of these resistant seedlings when used as parents in further

TABLE 6—*Certain conditions in relation to seasonal variation in leaf roll spread at Highmoor Farm*

Year	1938	1939	1940	1941	1942	1943	1944
Location, field	B	C	A,E	D	F	B	C
Leaf roll spread				More[1]			More[1]
Planting	5/2-5	5/18-20	5/15-23	5/7-9	5/4-8	5/20-25	5/5-9
Roguing[2]	6/20	7/14-25	7/10-23	7/2-15	6/22-7/20	7/7-26	6/30-7/9
Leaf roll rows dead[3]		8/24	9/4	8/22	8/30	9/20	8/20
Harvesting	Aug	9/18	10/2-3	9/22	9/8-14	10/11	9/5-19
Rainfall, inches							
June	3.8	2.1	4.0	1.0	6.6	2.9	6.4
July	6.3	3.3	3.4	4.2	3.0	3.7	2.9
August	2.3	4.3	2.0	4.1	1.2	4.4	1.3
September	6.0	3.8	4.7	1.0	3.3	1.8	6.1
Mean temperature[4]							
June	67	63	62	67	65	66	64
July	70	71	69	71	70	71	71
August	72	72	68	66	69	67	73
September	58	60	60	61	61	59	
Aphids per 50 leaves[5]							
7/1-8							11
7/9-16						12	
7/17-24				43	247	2	150
7/25-31		110	51	191	187	78	885
8/1-8		550		268		541	2238
8/9-16			640			1053	Few
8/17-24		160	782	0		1118	
8/25-31						1178	
9/1-8			490			3200	
Other insects							
Flea beetles[6]			Some	Many		Many	
Leaf hoppers[7]				Few	Few		
Tarnished plant bugs[8]				Many	Few		

[1]See Table 2
[2]Earlier roguing stage generally means earlier plant growth up to that time
[3]Chippewa, every third row, source of inoculum transmitted naturally
[4]From records made at Lewiston, 13 miles from Highmoor Farm
[5]Five of the compound leaves (at soil, near soil, near middle, near top, and at top of plant) from each of 10 Chippewa plants equally spaced across field.
[6]*Epitrix cucumeris.*
[7]*Empoasca fabae*
[8]*Lygus pratensis*

crosses can build up still greater leaf roll resistance Cockerham in Scotland concludes (5, p 107) from results of his test on field-resistance that they "at least indicate that within cultivated varieties there are hereditary factors controlling resistance to leaf roll and that these are several in number and are cumulative in their effect The factors are widely dispersed and their resistance value is almost entirely dissipated in out-breeding By close inbreeding within the small group of varieties and seedlings showing resistance, however, it should be possible to accumulate resistant factors in sufficient quantity to make them available for use in breeding for commercial purposes" In Germany (9), "the number of highly resistant offspring of a cross depends on the degree of resistance possessed by the parents," and "from crosses between two highly resistant varieties of *Solanum tuberosum* progeny may arise with a capacity for resistance surpassing that of the progenitors."

It remains to be seen how resistant to leaf roll the Highmoor Farm resistant seedlings will prove to be in other seed-producing regions where leaf roll is serious As pointed out previously, the natural spread of leaf roll in Maine has varied from one area to another in the same season, and from one season to another on the same farm Healthy stock in 1921 contracted more leaf roll on Long Island, New York, between 25 per cent leaf roll rows than in southern Maine between 100 per cent leaf roll rows, and least between 100 per cent leaf roll rows in northeastern Maine (26, p. 102) Healthy stock was again planted between leaf roll rows in 1922 in Virginia, in Long Island, in southwestern Maine, and in northeastern Maine (27, p 522); the leaf roll contracted averaged, for five varieties, 100, 72, 26, and 6 per cent respectively from the four areas Green Mountains and Chippewas exposed for three successive years in Maryland (31, p. 5) did not accumulate much more leaf roll in that time than was spread to healthy stock of these varieties each year at Highmoor Farm (table 1). Healthy plants between leaf roll rows or next to leaf roll rows contracted no disease in one part of Canada and up to 50 per cent and more in other parts, and contracted much more than in the second to fifth rows from leaf roll rows (21)

This variation between regions is not surprising Even if one species of aphid, for example *Myzus persicae*, were the only vector, its ability to spread leaf roll in the field could conceivably be affected by a number of variables such as

Duration of feeding on diseased plant (29)

Stage of growth of diseased plant when fed upon

Temperature

Stage of insects migrating

Number of insects migrating

Stage of growth of inoculated plant when fed upon

Duration of feeding on inoculated plant (29)

Chance for translocation of virus to tubers

Other aphid species and species of various kinds of insects have been regarded by one or another experimenter as more or less capable of functioning as leaf roll vectors (7) Therefore the assumption might appear still less justifiable that resistance at Highmoor Farm is closely indicative of resistance in other regions where potato leaf roll is important However, in Nebraska, with no aphids present, leaf roll was spread very little (13), and in Wales in locations where leaf roll increased in spite of roguing there were more than 500 *Myzus persicae* per 100 leaves in mid-July, whereas in locations where leaf roll did not increase there were 20 or less per 100 leaves (6).

It would be desirable to develop rapid artificial tests, with aphids or otherwise, which will eliminate seedlings that will be generally susceptible to field spread of leaf roll without also eliminating field-resistant ones that would be commercially desirable Tuber grafting in the U S. A. was found (31) to be too effective to permit the determination of useful field resistance In Ireland (18) stem-grafting and sprout infection by aphids readily infected two varieties that were highly resistant, one of them "resistant almost to the point of immunity", in the field

Incidental to tests of commercial varieties for resistance to aphids (1), 40 seedlings from Highmoor Farm in 1943 autumn were kindly tested in New Brunswick for aphid resistance One seedling that had been found to be susceptible to leaf roll (having 81 per cent) proved to be aphid resistant, while many of the more leaf roll-resistant seedlings were susceptible to aphid injury This indicates that the resistance to leaf roll exhibited by these seedlings is usually dependent upon host resistance to the virus rather than upon host resistance to the aphid vector Evidence in Australia (2) "suggests that differences in susceptibility to leaf roll in the commoner Australian potato varieties are a function of the plant tissues and not merely due to preferential feeding by aphids" Therefore, although aphid resistance is desirable for preventing direct injury from the feeding by the insects and

as a means of preventing field infection by leaf roll, it is not necessary for the development of field resistance to leaf roll

No commercial U. S. variety has all of the commercially desirable characteristics in the following list Nearly every one of these characteristics is absent, with its absence felt, in one or more of the important U S commercial varieties However, a few of the Highmoor Farm leaf roll-resistant seedling varieties have appeared to have many of these characteristics They are:

Sprout dormancy through 35°-40° F. storage
Quick sprout growth after cutting of seed and planting
Sprout limitation to one or two per eye at one time
Sturdy, rather erect vines
Quick growth and maturing of vines
Absence of non-virus leaf rolling
Tuber formation fairly deep in ground
Easy tuber detachment from vines at harvesting
Tuber skin light-colored, glossy, smooth
Tuber skin toughening early
Tuber shape rounded, thin to medium thick, under all growing conditions
Shallow eyes
Numerous eyes, as in Green Mountain
Tubers uniform and mostly salable as to size
Yield rate as high as that of the best commercial varieties
Freedom of tubers from hollow heart
Immunity to mahogany browning in 32°-35° F. storage
Immunity of tubers to stem-end browning and, if taking leaf roll, to net necrosis
Tuber flesh white,—before and after cooking
Tuber flesh mealy when baked, cohesive when boiled, and not too dark when french-fried
Cooked tubers as commendable as Green Mountains in flavor
Tubers with high starch content

The best-appearing Highmoor Farm resistant seedlings were tested on Aroostook Farm in Aroostook County in 1944 and 1945 Most of them failed to meet requirements as to yield rate or sprout limitation, too many sprouts per eye sometimes resulting in the tubers being too numerous and therefore too small (12) This difficulty as to sprout number has appeared to be inherent in certain seedlings regardless of region, season, storage temperature, or size of seed piece

In addition to securing leaf roll-resistant seedlings with sufficient commercial characteristics, it is desirable and should be possible eventually to combine leaf roll resistance and commercial desirabilty with resistance to other prevalent diseases and with resistance to prevalent injurious insects

Summary

Potato seedlings were exposed to field spread of leaf roll from adjacent rows in an area where leaf roll spreads consistently year after year Parents used at first included commercial American and European varieties reputed to be resistant to leaf roll, and a few of the crosses contained some seedlings resistant to the natural spread of leaf roll When these resistant seedlings were used as parents, the resulting crosses generally were more resistant to field spread than crosses of other kinds Greater resistance in one of the parents did not always mean greater resistance in the cross Greater resistance in a cross (on the basis of percentage of seedlings showing any leaf roll) was not necessarily correlated with the percentage of total plants showing leaf roll in the infected seedlings Field resistance in given seedlings and varieties varied from one season to another on the same farm Although green peach or spinach aphids (*Myzus persicae*) probably are an important factor in the field spread of leaf roll, aphid resistance in seedlings is not necessary for field resistance to leaf roll. It is possible to combine field resistance to leaf roll with many characteristics considered commercially desirable in this country

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THE ASCORBIC ACID CONTENT OF NEBRASKA-GROWN POTATOES AS INFLUENCED BY VARIETY, ENVIRONMENT, MATURITY, AND STORAGE[1]

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During the past three seasons more than 5,000 potato tubers have been analyzed for ascorbic acid. These represent several varieties grown at various places, under different cultural conditions, planted and harvested at different dates, and stored at a variety of temperatures. The results are being reported for the content of *reduced* ascorbic acid which was determined by the method of Loeffler and Ponting[5] with the modifications of Heinz and Kanapaux,[6] and the term ascorbic acid will be used throughout this paper to refer to reduced ascorbic acid.[7]

The sample used for analysis included 12 tubers representing the medium size typical of the lot being tested. These 12 tubers were then divided into three batches of four tubers each and a composite sample made from each batch. In this way each figure represents at least three separate analyses.

RESULTS

Variety. The ascorbic acid content of potatoes differs with varieties. Dependable differences among varieties can be established only after analyzing many tubers of each variety produced under different conditions, harvested at different stages of development, and stored at different temperatures. Frequently some of these factors may alter the

[1]Published with the permission of the Director as Jour. Paper No. 395 of the Nebr. Agr. Exp. Sta. This is a preliminary statement of the more salient findings in a comprehensive study which will be reported with substantial data at any early date.
[2]Department of Horticulture.
[3]Department of Home Economics.
[4]The detailed study of the storage phases of this project was made possible by a grant from the Refrigeration Research Foundation.
[5]Loeffler, H. J. and Ponting, J. D., Ind. Eng. Chem., Anal. Ed., 14, 846 (1942).
[6]Personal communication.
[7]The amount of dehydro was also determined but the results are viewed with caution because of possible inadequacies in present analytical methods. It appears that the dehydro form of ascorbic acid is present in relatively small amounts at the time of harvesting, that it increases slowly during storage, and at the end of the storage season may constitute a relatively large percentage of the total ascorbic acid even to the point of occasionally exceeding the amount of the reduced form found at that time.

comparative positions of varieties in regard to ascorbic acid content Of the varieties grown in Nebraska, Kasota tubers generally rank first, Triumph and Red Warba tubers are relatively high, and those of Irish Cobbler are relatively low in ascorbic acid. Several varieties were tested in the other experiments reported but Triumph and Red Warba were used most extensively.

Season: Potatoes harvested at practically the same stage of maturity in three different years differed greatly in ascorbic acid content

Maturity of Tubers Apparently the amount of ascorbic acid in tubers on green vines increases until the vines attain maximum growth Then as the vines mature the ascorbic acid content of the tubers decreases When the tubers are left in the field until the vines die down or later, their ascorbic acid content diminishes steadily,—sometimes very rapidly The highest values at the time of maximum plant vigor are generally from 35 to 55 mgs per 100 gms fresh tuber weight Tubers harvested a month later will usually have 30 to 40 mgs

Place Where Grown: The ascorbic acid content of potatoes grown at different places in the state seems to differ even though the potatoes are of the same degree of maturity Tubers with very high and very low ascorbic acid content were found at all of the locations from which tubers were procured Because of the great variation among tubers of different maturity, there is danger of drawing false conclusions unless large numbers of tubers from each location are analyzed On the same date the ascorbic acid content of potatoes grown in western Nebraska is higher than that of those grown in eastern Nebraska, but when they are harvested at the same physiological age the difference is small or non-existent

Method of Growing: Potatoes grown on dry land generally have a greater amount of ascorbic acid than potatoes on irrigated land Potatoes grown under a straw mulch have an appreciably greater amount than those grown without a straw mulch However, when tubers are harvested on the same day from plots or fields receiving different cultural treatment, much of this difference in ascorbic acid can be attributed to the difference in physiological age

Storage Although potatoes lose ascorbic acid at a relatively constant rate during storage, the storage temperature is an important factor Potatoes lose the least ascorbic acid when they are stored between 50° and 70° F As the temperature is lowered from 50° to 40° the loss steadily increases. When stored continually at 40° F potatoes usually lose as much ascorbic acid by mid-November as other tubers stored at

50° to 60° F lose by late February or early March The period of relatively high ascorbic acid content can be prolonged a number of weeks by storing potatoes at 50° to 60° F during the first twelve to sixteen weeks, using 40° F. storage only as early as may be necessary to retard or prevent sprout growth There is no indication in our data of an increase in ascorbic acid when tubers are brought from low and kept at a higher temperature for a time before analysis

Cooking: With the most careful methods of cooking, that is, using very little water and tight-fitting lids, cooking losses may be as low as five per cent, but when potatoes are boiled vigorously in a large amount of water, losses may be as high as 20 per cent or more

Changes in Sugar Content: With Triumph and Red Warba potatoes stored at 40° immediately after harvest, the sucrose content increases with great rapidity over a period of approximately two weeks and then decreases during a period of several months The reducing sugar content also increases, but somewhat less rapidly—the maximum content being attained in two or three months, after which time it decreases more slowly than does the sucrose content At 50° F there is little change in either reducing sugar or sucrose

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PRELIMINARY REPORT ON THE PERIODS OF CRITICAL NEED OF POTATOES FOR NITROGEN AND POTASSIUM*

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Little research has been done to determine the periods in the growth cycle of the potato when nitrogen is most needed, nor has the exact amount of nitrogen needed at the various periods been determined. Carolus (1) has made some studies showing needs of potatoes at different stages, and Hawkins (4) made a study of nitrogen and potassium absorption at 10-day intervals showing that most of the nitrogen and potash is absorbed in the late stages However, no correlations with yield seem to have been made to determine the optimum curve of critical need at the various stages of growth by means of tissue tests. This is what was attempted in the work reported in this paper with the purpose of enabling a grower to meet the needs at the late stages by the use of tissue tests The curves of need tell what is needed at a certain stage and tissue tests enable him to determine if what is needed is

there at any stage in the life cycle of the potato

In commercial production of potatoes, practically all nitrogen is added at planting, and no effort is made to see that enough nitrogen is available when tubers are sizing up. Work with tomatoes (2,3) has shown that large amounts of nitrogen are needed after the major blooming and setting period is over, in order to size up the fruits. It seems that this may be true also in the sizing up of potato tubers While phosphorus is the main element needed to balance the effect of nitrogen during tomato fruit set and to utilize nitrogen efficiently in the sizing up of tomato fruits, work with tissue tests has definitely shown that potassium is the important element needed to balance nitrogen during potato tuber set and to utilize nitrogen efficiently in sizing up of tubers This, of course, is linked with the association of potassium with the production and translocation of carbohydrate to the tuber.

In order to study the periods of need of the potato for nitrogen, field plots, sand cultures, and greenhouse plots were used with different soils and fertilizer additions The amounts of nitrogen in the tissues were followed by tissue (2) tests, and yields were recorded

The detailed results from all these plots will appear in a bulletin A preliminary summary of procedures and results is presented here

Summary of Procedures

Eighty field plots (10′ x 25′) were treated to vary the nitrogen available to potatoes at different stages of growth The same thing was done to 144 sand cultures in the greenhouse Tissue tests were run in the early stages,—just before bloom,—and after blooming was over The ppm of soluble nitrogen found in the tissues was correlated with yield of tubers, and the results for 1940, 1941, 1942 and 1943 are reported for the field plots and for 1941 and 1942, for the sand cultures

In the spring of 1943 four 2x2x2 factorial designs (5) including 32 plots (1½′ x 4½′ each) were started in the greenhouse Sodium nitrate was added at the start, before bloom, and after bloom with all possible combinations The results were analyzed for significant main effects and interactions in a manner described by Yates (5) and also by the standard t-test Two soils were tested and reported in spring 1943 (32 plots on each soil) two in fall of 1943, two in spring of 1944 and three in the fall of 1944

* The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director

In 1945 two series of 64 plots each were set up in split block Latin square designs with potassium applications made to the blocks and nitrogen applications made to the subplots. This was done on soil low in potassium and nitrogen, and the interrelationship between potassium and nitrogen was studied

Summary of Results

In general, the results show strong significance for late application of nitrogen, both for yield and size of tubers.

In round figures, the tissue test correlations showed strong positive significance for nitrogen in the tissues to a level of 1200 ppm in the early stage, to 990 ppm in the before bloom stage with significant negative correlation appearing at 1800 ppm, and strong positive correlation to 2500 ppm in the after-bloom period In other words, nitrogen in the potato plant should be twice as much after blooming is past as in the early stage and should not be very high just before bloom, to avert reduction in yield from excess nitrogen

In order to test whether these tissue test results would agree with the results from late applications of nitrogen, greenhouse plots were used to test out all combinations of early, pre-bloom and after-bloom or late application of nitrate of soda at the rate of 200 pounds per acre in most of the additions In this way large amounts of nitrogen would be present in the tissues late in the season and to agree with tissue test correlations the yields should be increased Nine different sets of plots in four different crop periods (spring and fall of 1943 and 1944) showed significant increases for the late application in most of the individual crops and when the average of all was taken, the plots on which late additions were made gave an average increase of 39 6 bushels per acre, which was a highly significant increase, whereas the application of all the nitrogen at the start gave an increase of only 9 bushels per acre, and was not significant Two applications, one at the start and the other after bloom, on the Experiment Station soil, gave the highest total yield of 252 bushels per acre The check produced 190 bushels per acre The application at the start produced only 199 bushels per acre, whereas the application after bloom, only, produced a yield of 242 bushels per acre These yields were obtained on the rich Experiment Station soil. This explains why the start application did not cause significant increases, but even on this rich soil late application caused significant increases This undoubtedly is because potatoes need a large amount of nitrogen late in the season, as shown by the tissue tests

Even rich soil cannot maintain enough nitrogen for maximum yield because of near exhaustion of the available supply in making early vine growth and because tuber enlargement calls for as much or more nitrogen in the late stages as is needed in the early vegetative stages

A poor soil from a terraced field on the Experiment Station farm was tested in the greenhouse for the effect of late application of nitrogen The check produced at the rate of only 75 bushels per acre Since it was known that potassium was limiting on this soil, as well as nitrogen, applications of 200 pounds per acre of potassium chloride were made Nitrogen alone at the start gave a yield of 109 bushels per acre, but the increase was not significant statistically When late applications of nitrogen were made, the yield was 115 bushels per acre, but still the increase was not significant However, the main effect (see Yates (5) page 10) for all late additions was highly significant When potassium was used and two applications of nitrogen,—one at the start and the other late,—were made, a yield of 138 bushels per acre was obtained,—a significant increase

Similar results were obtained on a poor, red soil, the check giving 174 bushels per acre Nitrogen applied at the start gave 183 bushels, and nitrogen both at the start and late gave 189 bushels, both increases being non-significant The main effect of all late additions, however, was again highly significant When potassium was included with applications of nitrogen, both early and late, the yield went to 298 bushels per acre, the increase being highly significant

When potassium was included in the treatment of the rich Experiment Station soil, however, potassium additions were of no value to the plot with the late addition of nitrogen producing the highest yield and giving a highly significant increase. Apparently plenty of potassium was available on this soil The results on the poor soils show that to get maximum benefits from late applications of nitrogen, adequate amounts of potassium must be present

All these results are recorded from greenhouse data. This accounts for the rather low yields Undoubtedly the greenhouse conditions were not ideal for potatoes. Most crops were grown during the long days of April and May, however, and had a season similar to the spring field crop, as far as light was concerned The results in the field have been ruined by drought so frequently that no conclusion can be drawn as yet Before making definite conclusions it is hoped to have several crops in the field during favorable seasons

Increase in tuber size from late applications of nitrogen was quite

similar to that of yield and was even more significant, in many cases This shows that the main effect of late application of nitrate is to increase the size of the tubers which have been set in the pre-bloom stage There were enough significant negative effects of the before-bloom application of nitrogen to show that yield is decreased by too much nitrogen in the pre-bloom stage This agrees with the tissue-test results This depression in yield seems to be due to decreased set, since tuber size often was increased by pre-bloom application of nitrogen

The results from the split block Latin squares for testing nitrogen and potassium inter-relationships show definite responses and interrelationships, although some of the results have been out of line Tissue-test results showed why certain plots were out of line For some unknown reason the same treatments were not consistent in producing the same levels of nutrients in the tissue, thus suggesting why certain yields were out of line The tissue test data show when nitrogen and potassium are needed and preliminary balance curves of critical need have been made but as yet not enough data have been obtained to establish these curves as definitely as has been established for the tomato (2).

Most potato growers apply all nitrogen at planting time These results indicate they are not reaping full benefit from nitrogen applicaion when this practice is followed It seems it would pay commercial growers to make a late application as well as the one at the start of the crop It might pay to reduce the start application and apply twice as much just after the bloom period is over, provided, of course, that moisture conditions are favorable at this time to continue growth of the crop and if potassium additions are made where there is danger of this element being deficient

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SECTIONAL NOTES

CALIFORNIA

The potato growers in Kern County as of the 20th of June, had marketed by rail, for retail consumption, an estimated 22,150 cars On the same date there had been shipped by rail 963 cars purchased by the government. On the same day, the Market News Service estimated that a total of 10,860 truck loads had been delivered to the government, or an estimated 5,467 cars going to the government as of the 20th of June It is also estimated that this potato harvest will close in Kern County by the 5th of July with the exception of a few car loads

The majority of the potatoes purchased by the government are going to be used for the manufacture of alcohol Since the alcohol manufacturers were unable to use the potatoes as rapidly as harvested, it is estimated that more than 4,000 cars have been spread upon airports in this county and are now being sun dehydrated Various methods have been used to crush the potatoes in order to secure rapid dehydration (June 26).—M. A. LINDSAY.

In California we have found that 62,000 acres of potatoes can produce 44,000 cars as follows· to airstrips, 9,000; trucked to dehydrators and processors, 5,000; trucked comercially, 5,000; and shipped by rail, 25,000.

These are the estimated figures as far as the trucking is concerned but they are substantially correct These figures mean an average yield of approximately 285 sacks (10 lbs.) per acre!

Besides these record yields, the Kern County Potato Deal contained just about every known phase, in addition to a few highly novel ones.

Among the latter were,—the railroad strike, a very severe car shortage toward the end of the Deal—and—the practical working out of the Government Support Program.

As shown above, 9,000 cars (the correct figure including June 30 is 9,071 cars) of potatoes have been deposited upon various paved Airstrips in Kern County for "sun-drying" preparatory to distilling (July 3) —ERNEST MARX.

FLORIDA

Conditions were very favorable for the production of potatoes in the Hastings Section, Florida, in 1946. Approximately 5,000 carloads were produced on 13,000 acres, and the average yield was about 250 bushels

per acre Yields exceeding 400 bushels per acre were reported from a few yields

Prices were also good as FOB sales ranged from $3 00 to $4 25 per hundred pounds for U. S No 1 grades during most of the season.

Late blight threatened to become serious during the latter part of March but dry weather checked its development during April. Some of the early-planted crops would have been severely damaged by blight if they had not been protected by weekly applications of Dithane spray and copper dusts (July 8) —A H EDDINS

GEORGIA

We have had a rather serious outbreak of late blight in Georgia,—beginning in the southern part of the state,—on both potatoes and tomatoes It has recently made its appearance in the potato fields in North Georgia.

I have recently given some demonstrations using Basic-Copper, Fermate, and Dithane D-14. The results of these materials will be given in detail, in the next issue.

The yield of potatoes has been better than average, other than in fields seriously affected with the late blight. The new varieties, Sequoia, and Pontiac are showing up well in the mountain section of the state. (June 24) —ELMO RAGSDALE

INDIANA

Our potato growers have been blessed with a little bit too much moisture and there was considerable damage to potatoes—on muck—this past month In some areas, as many as 10 to 20 acres have been drowned out In one field that I saw, the waves were lapping on the high ground, not a sign of potatoes, and there were about 40 acres in this field lost. Some of the growers are going to replant if they can find seed

We also find considerable black leg and rhizoctonia doing damage to the potatoes and the growers have had to fight the flea beetle and the leafhopper which has necessitated a lot of extra spraying. Otherwise we are in good shape (June 24) —W B WARD

IDAHO

Planting is completed and a large part of the crop is above ground Indications are for a better than average stand in Eastern and Southern Idaho. A brisk demand for certified seed developed toward the end of the planting season,—due partly to replanting of abandoned beet acreage

to potatoes. All the certified seed has been sold and growers report the late demand exceeded the supply, this in spite of the largest crop of certified seed potatoes in the history of the state All the applications for certification will not be in until the 1st of July, but it appears that the acreage of potatoes for certification will be slightly lower than in 1945 The total acreage of potatoes in the state is probably more than indicated in the March 1 report but slightly lower than 1945 Improvement in potato markets, increase in support price and abandonment of some sugar beet acreage have all contributed to changing the growers intentions. The acreage of early Russets in Southwestern Idaho is reported to be only about one-half that of last year and conditions of fields in this area are rather poor Several fields have been slowed up because of a high percentage of leaf roll. However, the condition of early varieties in southwestern Idaho appears to be about "normal" (June 26).—JOHN R ROBERTSON.

KENTUCKY

Irish potatoes are well advanced, and the condition of the crop is generally good, in fact,—above average Some harvesting is beginning in the Louisville area, and both yield and quality are very good Advanced publicity to date has built up considerable concern among our growers regarding the price situation. We anticipate harvesting this crop not only with a high yield per acre but with potatoes having good quality. Our harvesting operations will be completed during July,—providing the market situation is such as to permit their being improved. (June 20) —SHIRLEY W. ANDERSON

LONG ISLAND

The acreage of potatoes in Suffolk County is about the same as last season.

The germination was better than usual Many of the larger growers treated their seed for Fusarium. All the growers who used DDT found almost no insects on the vines.

A very heavy rain on the 1st of June hurt the crop, by leaching the light spots and causing too much water in the low spots.

There has been no rain in two weeks except for a few local showers. Rain is now badly needed (June 29) —H R TALMAGE.

MAINE

Maine has entered approximately 77,100 acres for certification according to E L Newdick, Chief, Bureau of Plant Industry. This is the largest ever filed in the state

The fertilizer shortage which seemed apparent in April was not so acute when it came to actual planting. Although the supplies were not liberal, farmers were able to get fertilizer finally and instead of the 5 per cent cut, which was the guess estimate in the May notes, the acreage was actually increased The general feeling is now that Maine has slightly more than the 209,000 acres credited in 1945. The estimate which was made by the USDA on the 10th of July is the figure which should be considered accurate for Maine.

Indications are that many farmers are using DDT this year No estimates have been made as yet, but it will be used freely and should result in increased yields. Our experiments last year indicated an average increase of about 18 per cent on all experiments

Some additional storage is being built this year but with a big crop some farmers will have a storage problem in the fall, unless plans are made by the USDA to develop price support features which will move the crop in the early fall

The Aroostook County Farm Bureau will hold its annual Field Day at Aroostook Farm (the field experiment station) on the 7th of August at Presque Isle The principal speaker will be Commissioner of Agriculture Dumond of New York.

Conditions have been rather favorable up to the 1st of July for the development of the crop Local showers on the 1st of July were a bit severe in some areas and caused a little damage, but on the whole, the showers were helpful to the county (July 2).—VERNE C. BEVERLY

MINNESOTA

Potato planting conditions throughout the state have been more satisfactory this season than for several years A freeze early in May nipped the early plantings in the sand land area, but the plants have recovered and are making satisfactory progress. The set-back probably means delayed harvesting for approximately a week In the Red River Valley, planting got underway shortly after the 15th of April and many fields planted for certification will be ready for the first inspection this week Intentions to plant, reported early this spring, indicated that the acreage in the state would be reduced approximately five per cent below the 1945 acreage No figures are available yet as to whether these intentions have been carried out.

Applications for certification inspection are nearly completed and it is apparent that we will have approximately 35,000 acres to inspect This is just about the same acreage as we inspected in 1944 and 1945 More good foundation stock has been planted for certification inspection

than ever before, although we have been short of foundation seed in such varieties as Triumphs, Sebagos, Chippewas and Ohios.

General timely rains occurring throughout the state have resulted in getting all potato plantings off to a good start and, barring unfavorable weather later on this season, our certified seed potato growers should harvest a fine crop of high quality seed potatoes. (June 24) — A G. TOLAAS

NEBRASKA

In central Nebraska, otherwise known as the early producing area in Nebraska, harvesting operations will begin about the 20th of July. Good yields are expected in spite of the heavy freeze which froze plants off to the ground level early in May.

In western Nebraska ample rainfall this season has produced very favorable conditions for planting and a favorable outlook on the crop in general this year. Planting has just been completed. Our certified acreage has increased by approximately 10 per cent above that of last year. Our commercial or table potatoes planted will amount to about the same as last season.

Many fields that are now up show excellent stands and vigorous plants. Ample subsoil moisture on the dryland and sufficient irrigation water under the irrigated area should be very favorable for the growth of the plants throughout the season. (July 5).—J. J SHAUGHNESSEY.

NEW YORK

The season for up-state New York growers opened up a bit earlier than normal and a lot of potatoes were planted at least three weeks ahead of time. This early season was followed by too many heavy rains, and as a result late plantings are no earlier than normal.

Generally speaking, the condition of the potatoes, that are up, is reported as good Plenty of moisture and cool weather have been favorable for good germination and stands are reported as extra good. This applies to all sections with the exception of the low spots where excessive water has rotted the seed pieces

As far as the acreage is concerned, it seems to be the consensus that the government estimate of 12 per cent less than last year is about right Many of our larger growers have reduced quite a bit and most dairymen who used to raise 5 or 6 acres now find it more profitable to raise that much more silage and keep a few more cows. The net result of community spray rings seems to have been to increase the acreage of some growers and to have decreased the acreage of many of these

small growers whose acreage was too small for efficient digging and handling operations. Incidentally, several of our spray ring operators have given up custom spraying and gone into business for themselves on a larger scale.

Our growers of certified seed paid more attention this year to their foundation stock Probably the biggest percentage ever, of southern tested and proven seed and seed from carefully rogued Tuber-Unitted fields were planted this year. More and more we find the seed business developed under the management of seed-conscious growers Many growers who formerly used to certify part of their acreage,—due to scarcity of help,—which precluded careful roguing are not attempting certification, but prove to be excellent customers for certified seed

The earliest planted potatoes in up-state New York are on the muck areas and preliminary reports indicate an excellent crop prospect. The harvesting of these early areas will undoubtedly begin in August.

There is much interest among commercial potato growers in improving the grade and package this coming season During the past few years when there was no premium for quality pack and package, New York lost what she had gained in the previous decade in this connection.

The Summer Field Day of the Empire State Potato Club is scheduled for the 8th of August on the farm of Burt Peffer at Bliss, New York, which is in southern Wyoming County There is a possibility that the date may be changed but extensive plans are being made and we are assured of a lot of demonstrations of new farm machinery including diggers, pickers, conveyors, and graders. Manufacturers of all farm machinery have been asked to exhibit,—with emphasis of course on potato equipment Not only will machinery be on display but as many machines as possible will be demonstrated. Besides the machinery features the College of Agriculture and Experiment Station has a three-acre plot planted to show difference in fertilizer materials and methods of application, new varieties, effects of new insecticides and fungicides, results of irrigation and other interesting features, including growing examples of virus diseases for those who may be interested

The following week the Adirondack Potato Growers' Association will hold a similar Field Day at Malone, New York, and any visitors who wish to take in both field days will be able to get information regarding the best camping and fishing areas for the interim period, by writing the general chairman, J B Ketcham, Wyoming County Agricultural Agent, Warsaw, New York (June 21) —H J. Evans


DDT
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OHIO

Some early potatoes are being harvested along the Ohio River The early crop is at least a week to two weeks earlier than usual Harvesting will get under way in bulk by the first of August and it is usually about the 10th before any volume is available. The early prospects are excellent. There were heavy rains in some sections during June, but on the whole little damage was done Probably the greatest amount of water damage was on the muck. It is estimated that the damage throughout the state is not more than a total of 2 per cent from water.

If the crop receives a rain within the next few days it will result in the addition of many bushels to the crop The prospects at the present time are for high yields, but dry weather at present would reduce the crop to some extent.

The second crop potatoes were planted late because of heavy rains during the latter part of May and the first part of June The water damage on the late crop will no doubt be greater than on the early one. The heavy rains that occurred following planting have caused some rotting of seed pieces.

The acreage has not changed much since last year except that we find more small garden patches of potatoes with a few rows,—but the trend has been for large commercial acreages and small garden patches Many of the small growers,—who have been growing five to ten acres have discontinued potato production so that now we do not have many small growers of acreages running from five to fifteen acres. DDT has given excellent control of leafhoppers and will no doubt result in increased yields of potatoes. (July 6) —Earl B. Tussing

OREGON

Potato planting was completed on the 1st of June with excellent conditions prevailing throughout the entire planting season Although the soil was dry at time of planting, a heavy rainfall relieved this situation late in May

The acreage seems to be around 26,000 in the Klamath Basin, or about 10 per cent under 1945. Certification of White Rose will be fully equal to 1945, but some decrease is expected in Russets (Netted Gems).

The State of Oregon and Klamath County have inaugurated a disease control program this year to increase both the quality and quantity of certified seed potatoes At the present time the first field inspections for the presence of aphids and other similar insect pests are being made. Considerable dusting will be undertaken to reduce insect populations (June 21) —C A. Henderson.

SOUTH CAROLINA

The South Carolina potato crop moved to market prior to the 8th of June. Prices during the last few days were unsatisfactory Apparently, some loss in transit can be attributed to late blight which became epidemic during the harvesting period. Some losses were attributed to delays during the rail strike (June 18) —W. C BARNES.

SOUTH DAKOTA

The moisture supply in the last half of June was far above normal in the potato section in South Dakota which centers around Clark and Watertown, in the Northeastern part of the state The potato fields look very good and the stands are excellent in most fields Over 7,000 acres have been entered for certification this year which is a decrease of about 20 per cent from the number of acres entered last year. David Giese of Moorhead, the new field inspector, found the fields in very good condition with very little virus disease Flea beetles have been numerous but growers are dusting and one large operator is using a wet spray this year. The moisture during the past two weeks could make conditions favorable for late blight if the weather would remain cool but in this season of the year we can expect more warm days than cool days Early planted Warbas have set heavily and will be ready to dig the first part of August Everything at this writing, the 3d of July, points to a good crop (July 3) —JOHN NOONAN

ERRATUM

In the June 1946 issue of the American Potato Journal, page 202, paragraph 5, line 3 (line 37 on page) which reads "The data were evaluated by determining that value in a comparison of the groups" should read "The data were evaluated by determining the *t* value in a comparison of the groups."

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POTATO SPRAY TESTS IN ONTARIO[1]

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In Ontario in recent years, Bordeaux mixture or fixed copper sprays, and copper-lime or fixed copper dusts, with calcium arsenate added in the early applications, have not given satisfactory control of either diseases or insects in some seasons The control of leafhoppers has been especially unsatisfactory Therefore, in 1945, at the request of the Ontario Crop Improvement Association, this project was started with the object to re-assess the value of well known spray and dust materials and especially to ascertain the value of some of the newer fungicides and insecticides, more particularly Dithane, Lethane B-72, and D D T

This co-operative project was under the joint supervision of the Dominion Laboratory of Plant Pathology, St Catharines, Ontario, and the Department of Entomology, O A C , Guelph Funds were pro-

[1]Contribution No 864 from the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada, in cooperation with the Department of Entomology, O A C , Guelph

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vided by the Dominion and Provincial Departments of Agriculture and the counties of Middlesex, Brant, Norfolk, Oxford, and Elgin

The experiment was located on the farm of Robert McArthur, R. R. No. 2, Strathroy, and comprised approximately one and one-half acres There were 150 plots,—each being 4 rows wide and 10 feet long,—consisting therefore of 40 plants Unsprayed buffer plants surrounded each plot The plots were planted by a single-row planter on the 31st of May and the 1st of June, and—later, misses were planted with transplants so that there was a perfect stand of plants in each plot.

There were thirty different treatments (Table 1), each replicated

TABLE 1. *Fungicides and insecticides*

Plot No	Materials	Formulas
	DUSTS	
1	Copper oxychloride sulphate (C O C S)	6½% Cu
2	Copper A	5% Cu
3	Copper-Lime	6½% Cu.
4	Copper-Lime+Lethane B-72	6½%-4%
5	Copper-Lime+D D T (Neocid)	6½%-1%
	SPRAYS	
6	Bordeaux mixture	4-4-40
7.	Bordeaux mixture+Lethane B-72	4-4-1½-40
8.	Copper oxychloride sulphate (C O C S)	3′ 13″ to 40
9.	C O C S +Lethane B-72	3′ 13″-1½-40
10.	C O C S.+Zinc sulphate+lime	3′ 13″-½-¼-40
11.	Copper A	2¼-40
12	Copper A+Zinc sulphate+lime	2¼-½-¼-40
13.	Dithane+Zinc sulphate+lime	2 qts -1¼-⅝-100
14	Dithane+Zinc sulphate+lime +Lethane B-72	2 qts -1¼-⅝-3¾-100
15.	Puratized N5E	8 oz -100
16	Puratized N5E+Lethane B-72	8 oz.-3¾-100
17.	Fermate	1-40
18.	Fermate+Lethane B-72	1-1½-40
19.	Fermate+Zinc sulphate+lime	1-½-¼-40
20	Lethane B-72	1½-40
21.	Spraycop	3½-40
22	Isothan	1 pint-100
23	Bordeaux mixture+Lethane B-72 (delayed)	4-4-1½-40
24.	Bordeaux mixture+D D T (AK 40)	4-4-5″-40
25	Control	——
26.	C O C S +D D T (AK 40)	3′ 13″-5″-40
27.	Dithane+Zinc sulphate+lime +D D T. (AK 40)	2 qts -1¼-⅝-12½ oz -100
28	Puratized N5E+D D T (AK 40)	8 oz -12½ oz -100
29.	Fermate+D.D T (AK 40)	1-5 oz -40
30.	D D.T (AK 40)	5 oz -40

Note. Unless otherwise stated, figures refer to pounds, except last figure which refers to Imperial gallons of water.

5 times, and carefully randomized in such a manner that each treatment was represented, but not duplicated, in each of the 5 series of thirty plots, as shown in chart 1.

CHART 1. *Outline of plan of experiment showing the location and randomization of the plots, by number, in the field*

29	23	2	6	16	9	12	7	28	11
22	13	26	5	24	25	20	15	18	30
1	10	8	17	14	21	27	3	19	4
30	19	21	7	11	6	14	25	13	10
8	3	15	27	28	2	24	5	1	29
9	20	4	16	18	17	26	22	12	23
12	24	30	25	8	7	18	2	14	20
11	15	9	19	10	27	6	28	5	16
4	26	13	29	3	1	17	23	21	22
18	25	11	12	23	4	9	30	17	27
2	6	24	20	19	15	16	1	26	3
5	21	28	14	29	22	10	13	7	8
28	27	3	22	20	12	11	29	25	15
7	16	1	18	30	13	19	21	2	9
17	14	23	10	5	26	8	4	6	24

Note.
The numbers of above plots refer to the materials as given under "Fungicides and Insecticides" in table 1 Therefore, plot 1, wherever it is shown on plan, is dusted with C O C.S , plot 2 with Copper A dust, etc

Spray and dust applications were started on the 6th of July when the plants were 9 to 12" high. The first four applications were applied at 10-day intervals whereas the remaining five were applied weekly. The dusts were applied with a Cylindro hand duster and the sprays with a 30-gallon power sprayer delivering 200-250 pounds pressure

All check plots and buffer plants were sprayed three times with calcium arsenate to control colorado potato beetles Calcium arsenate was added, for the same reason, to the first three applications of the sprays and dusts, except those containing D D T.

During early July there was slight general feeding by potato beetles but the treatments soon gave effective control on all plots. Flea beetle injury became apparent by the 20th of July and increased on all buffer plants and unprotected plots, but was unimportant on all D D T. plots. Though aphids (*Myzus persicae*) were present in moderate numbers on most plots, they were absent from all plots which received D D T.

Leafhoppers, by far the most serious insect present, were observed on many of the plots by the middle of July, and shortly thereafter hopperburn appeared on the foliage on all buffer plants, check plots, and treated plots where D D T. was not applied On all plots where leafhoppers were not controlled, hopperburn increased so rapidly that other types of injury could not be evaluated and by early September the foliage on unprotected plants was almost entirely brown and dead

However, not only were leafhoppers and hopperburn absent from all D.D T plots, but the foliage on these plots was unusually healthy and free from insect injury of any kind Accordingly, D.D T. gave most satisfactory control of *Myzus persicae*, Colorado potato beetle, flea beetle, and leafhoppers Early blight (*Alternaria solani*) was observed in a number of plots by the third week in July, and late blight (*Phytophthora infestans*) at the end of the month Both these diseases increased throughout the season on buffer plants, check plots, and plots receiving only D D T However, later in the season, hopperburn was so serious on all plots where D D T was omitted that an evaluation of blight control was possible only on those plots which received D D T. and were accordingly free from hopperburn

Bordeaux and Dithane + Zinc sulphate + lime gave good control of both early and late blight C O C S, Copper A, and Spraycop were next in order of effectiveness with a trace of both early and late blight in all plots, whereas Fermate and Puratized were less effective.

Isothan failed to control either blight Puratized gave better control of late blight than it did of early blight

The addition of zinc sulphate + lime to C O.C S, Copper A, and Fermate improved blight control appreciably.

The criterion used to estimate the effectiveness of the various spray materials employed was the yield of tubers calculated in terms of bushels per acre The plots were harvested October 15-17 All yield data are based on weights of potatoes harvested from the two center rows of each plot as noted in table 2

The data in table 2 indicate several important facts The greater yield in the D D T plot compared with the check and the various plots receiving fungicides only indicates not only that D D T controlled insects effectively but also that insects (leafhoppers) were more responsible for the decreased yields than were early blight and late blight

These same facts are indicated by a comparison of the various plots receiving fungicides only with the plots receiving the same fungicides plus D D T,—as for instance, Dithane and Bordeaux compared with Dithane + D D.T, and Bordeaux + D D T

TABLE 2—*Average yields in bushels per acre from the various plots*

Fungicide	Fungicide				Fungicide + Insecticide			
	Plot No	Alone	Plot No	+Zinc Sulphate +lime	Plot No	+Lethane B/72	Plot No.	+DDT
COCS dust	1	277±19						
Copper-lime dust	3	273±12*			4	277±30	5	287±27
Copper A dust	2	240±16						
Bordeaux spray	6	311±16			7	326±23	24	507±34
COCS spray	8	287±14	10	314±27	9	324±19	26	507±48
Spraycop spray	21	269±19						
Copper A spray	11	255±12	12	290±11				
Dithane spray			13	333±23	14	445±30	27	618±40
Fermate spray	17	244±18	19	276±11	18	307±20	29	524±18
Puratized spray	15	217±17			16	320±23	28	413±32
Isothan spray	22	208±12						
Check (No fungicide)	25	236± 4			20	284± 8	30	398±39

Note The plus and minus figures indicate the average variation within the 5 plots
*Underlined yields significantly better than check

The yields of potatoes were greater where zinc sulphate and lime were added to C.O.C.S., Copper A, and Fermate than where these materials were used alone.

Though Lethane B-72 gave some control of leafhoppers, it was, in all cases, inferior to D.D.T.

As it was to be expected, D.D.T was ineffective in controlling leafhoppers when added to copper-lime dust.

FIGURE I Photograph showing yields from Dithane and Bordeaux plot with and without D D.T in comparison with check plot and plot receiving only D.D.T.

COMPARATIVE EFFECTIVENESS OF CERTAIN KNIFE DISINFECTANTS AND THE USE OF THE DOUBLE-EDGED KNIFE FOR THE CONTROL OF RING ROT OF POTATOES[1]

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Introduction

Investigations have shown that the power-driven rotary cutting knife (3) turning in a solution of mercuric chloride (0.2 per cent) or in boiling water gives adequate protection against the spread of ring-rot infection caused by *Corynebacterium sepedonicum* (Spieck and Kott) Skapt and Burk (1, 5, 7, 10) The principal limitation to the use of mercuric chloride solution is that the disinfectant becomes ineffective after several hours cutting, and failure to replace the vitiated solution may result in serious ring-rot dissemination (1, 7) Further, the use of chlorine in solution, utilizing either sodium or calcium hypochlorite, appears to be hazardous because of rapid inactivation of the chlorine and loss of chlorine from solution (1) Finally, the use of boiling water, although not subject to the same limitations as solutions of mercuric chloride or chlorine, has certain disadvantages. Careless operators have often failed to maintain boiling temperatures, and when heating units failed in service,—particularly those operated by electricity,—they were frequently not replaced or were not replaceable. For these reasons, research has been continued with the hope of finding a relatively non-injurious disinfectant which would act as an effective bactericide as well as possessing a maximum stability both in solution and in the presence of organic material.

In addition to the practical difficulties of disinfecting the rotary knife, another problem has developed in Colorado. Many small-scale growers of seed as well as numerous commercial growers have not seen

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[2]The writers wish to thank Mr W. F. McGee, Superintendent of the San Luis Valley Demonstration Farm, for his help and assistance during the course of the work In addition, they wish to acknowledge the cooperation and assistance of Dr L. A Schaal, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U S. Department of Agriculture, and Mr W C. Sparks, Section of Horticulture, Colorado Agricultural Experiment Station during certain phases of this work They also desire to express their appreciation to Professor Andrew G Clark, Head of the Department of Mathematics of Colorado A & M College for assistance in the mathematical analyses herein

fit to use rotary cutting knives, principally because of the cost of construction or purchase For such growers a simple stationary double-edge knife has been devised, disinfected by a 0 2-per cent solution of mercuric chloride (9) Although appearing to be a very practical solution to the problem, it was considered necessary to compare the efficacy of this knife in controlling the spread of ring rot with that of a similarly disinfected power-driven rotary knife.

Another consideration was the danger of infection from the surface of the cutting table adjacent to the rotary knife (platform boards or plates) Although the majority of trained seed cutters avoid seed-piece contact with the platform boards or plates, many cutters still slide the tubers across the platform while in the act of cutting It has been felt for a long time that this practice might bring about some appreciable spread of the disease For this reason, a limited test was conducted to determine the actual amount of infection from such a source following the cutting of tubers with a rotary knife disinfected with a 0.2-per cent solution of mercuric chloride.

Methods

A supply of Red McClure seed potatoes, presumably free from ring rot, was divided into 21 lots of 110 tubers each From each lot nine to ten tubers were selected at random to supply an additional lot of 200 tubers which was held as an uncut control to test for the presence of ring rot in the seed. The balance of the tubers, consisting of 21 lots of 100 tubers each, were halved with either the rotary knife or the double-edged knife, giving 200 seed pieces (halved tubers) for each test lot

The power-driven rotary knife was used to test the effectiveness of several bactericides The knife blade rotated in a one-gallon tank of disinfectant at a speed ordinarily used in commercial cutting and was contaminated by rubbing the cut surfaces of an infected tuber over the knife surfaces Infestation of the knife was repeated for every ten tubers cut. Chemicals tested were solutions of Roccal (a mixture of alkyl dimethyl benzyl ammonium chlorides) in concentrations of 2 per cent (1-50), 1 per cent (1-100), and 0 5 per cent (1-200), Hyamine 1622 25 per cent (di-isobutyl phenoxy ethoxy ethyl dimethyl benzyl ammonium chloride) in concentrations of 0 2 per cent (1-500), 0 1 per cent (1-1000), and 0 05 per cent (1-2000), and cresol (phenol coeff. 5) in 1- (1-100), and 2-per cent (1-50) solutions These disinfectants were compared with the standard 0 2-per cent (1-500) mercuric chloride solution and with boiling water. In addition the same strengths of cresol solution were tested, using a non-contaminated knife, to measure possible stand reduction

In a series of treatments the disinfection of the stationary double-edged knife was tested. This knife was compared with the standard power-driven rotary knife using a 0 2-per cent solution of mercuric chloride as the disinfectant. In addition a surface tension reducing agent, Vatsol OT 85 per cent was added to the disinfectant solution for two trial lots on each knife The double-edged knife (9) consists of a 6- to 8-inch blade sharpened on both edges and clamped upright to the edge of the cutting table In order to disinfect the knife automatically a short section of lamp wick, connected by a small rubber tube to a 5-gallon can containing the disinfectant, is fitted over the tip of the knife. A metal valve fitted to the base of the can permits the operator to regulate the rate of flow of the disinfectant A small metal trough is fitted around the base of the knife to receive the used disinfectant and convey it to a waste can. The knives were contaminated for every 10 tubers cut for each test lot in the same fashion as previously described.

To test the possibility of spread of infection by contact with the cutting table following the cutting of seed pieces with a mercuric chloride disinfected rotary knife, the platform boards at the side of the knife were smeared with a ring-rot infected tuber This process was repeated for every 10 tubers cut The knife was not contaminated. Immediately following the cutting of each tuber, the cut halves were placed face down and pushed firmly but without undue pressure across the contaminated boards This treatment was compared with test lots cut with a contaminated knife without disinfection, and with a contaminated knife turning in a 0 2-per cent solution of mercuric chloride The knife was contaminated in the same fashion as in other tests.

Each of the 22 test lots of tubers and tuber halves were randomly divided into four sub-lots of 50 seed pieces each and planted, one and two days after cutting, in a four-block, randomized plot The planting date was May 17, 1945. A power-drawn, two-row, assisted-feed type planter was used The sprocket wheel, plate, and drop tube of the planter were disinfected with 0 2-per cent mercuric chloride solution after each sub-lot was planted

Final records were taken on the 29th, 30th, and 31st of August, 1945. Ring-rot determinations in the mature plants were made by aerial symptoms, by tuber examination, and by constant use of the stem-ooze test (2, 4, 7). The experiment was conducted at the San Luis Valley Demonstration Farm near Monte Vista, Colorado (altitude approximately 7,600 feet)

Experimental Results

In order to simplify the presentation of data, results are presented

in three pertinent tables rather than in one general table. The stand data in each table were subjected to a separate variance analysis (8).

Disinfection of the power-driven rotary knife—The results of the study comparing the efficacy of the different disinfectants and concentrations tested are shown in table 1. Because of the relatively high incidence of blackleg and seed-piece rotting throughout the San Luis Valley as well as in the test plots this year, ring-rot records were taken only on living plants.

TABLE 1.—*The comparative effectiveness of five rotary-knife disinfectants in the control of ring rot (Results presented as 4-plot averages)*

Treatment No.	Contamination of Knife with *C. sepedonicum*	Type of Knife Disinfection	Average Stand per Plot	Per cent of Living Plants Showing Ring Rot
1	Uncut tubers	———	46.50	0.54
2	+	None	28.00	75.89*
3	+	Boiling water[1]	42.25	1.18
4	+	$HgCl_2$ (0.2 per cent)	46.50	0.54
8	+	Roccal (2 per cent)	32.00	12.50*
9	+	Roccal (1 per cent)	30.00	27.50*
10	+	Roccal (0.5 per cent)	28.00	28.57*
11	+	Hyamine (0.2 per cent)	30.25	35.54*
12	+	Hyamine (0.1 per cent)	33.75	23.70*
13	+	Hyamine (0.05 per cent)	36.25	55.86*
14	—	Cresol (1 per cent)	38.75	0.00
15	—	Cresol (2 per cent)	38.50	0.65
16	+	Cresol (1 per cent)	37.00	8.11*
17	+	Cresol (2 per cent)	36.50	1.37
Difference req. for significance.				[2]
5—per cent level			4.90	...
1—per cent level			6.55	...

[1]Boiling point 199° F.

[2]Since the seed used showed a small percentage of ring rot, the determination of significant increase of ring rot in the test lots was based on the Poisson distribution in which $P_x = \frac{e^{-Np}(Np)^x}{x!}$ (8). Test lots in which the number of diseased plants is excessive (1-per cent level of significance, starred (*).

The data in table 1 indicate that a small amount (0.54 per cent) of ring-rot infection was present in the seed tubers prior to cutting. However, by applying the Poisson distribution to the actual numbers of healthy and infected plants per treatment, the relative success or failure

of any given treatment could be determined (see table 1, footnote 2) As expected, the use of the contaminated but non-disinfected knife resulted in a high percentage of ring rot (75 89 per cent). Both boiling water and mercuric chloride solution prevented spread of the disease. Roccal and Hyamine in all concentrations tested either failed to control ring rot or gave incomplete control, resulting in infected plants from 12 50 to 55 86 per cent Cresol in 2-per cent solution gave control, but at 1 per cent, control was not complete (8 11 per cent disease)

In treatments where control was ineffective or incomplete, a marked reduction in stand occurred The average stand differences between such treatments and treatment 4 (knife disinfection with 0 2-per cent mercuric chloride) were highly significant.[3] The stands obtained following the use of 1- and 2-per cent Cresol solutions, irrespective of knife contamination, also uniformly showed highly significant stand reductions.

The difference between the average stand obtained following the use of boiling water and that resulting from the use of 0.2-per cent mercuric chloride solution, although rather strongly favoring the chemical disinfectant, was non-significant (odds only about 10:1)

The effectiveness of the double-edged stationary knife in controlling ring-rot—The results of the study in which the power-driven rotary knife and the stationary double-edged knife were compared are shown in table 2.

In the analysis of the original disease data, the Poisson distribution was again applied to determine whether small amounts of disease which occurred were in excess of that which might be expected to be originally present in the seed tubers As may be seen in table 2, all disinfected double-edged knife treatments, with the exception of treatment 20, gave as complete a control of ring rot as did all disinfected power-driven rotary knife treatments In treatment 20 a double-flow rate (two quarts per hour) of mercuric chloride solution was used. In this case the figure 3 57 per cent appears to be an excessive amount of disease, indicating that the treatment was not complete in control. The non-disinfected and contaminated knife treatments for both types of knives used gave a high percentage of ring-rot infection (75 89 and 72.03 per cent disease). In only these two cases were the stands appreciably reduced, and in both instances stand reduction under all other treatments was highly significant

The effect of platform-board contamination following cutting with a disinfected rotary knife (0.2-per cent mercuric chloride)—The data in table 3 show the effect of exposing seed pieces cut by a disinfected

[3]"Highly significant" refers to the 1-per cent level of significance (odds 99:1). "Significant" is used to indicate the 5-per cent level of significance (odds 19:1).

TABLE 2.—*The comparative effectiveness of the rotary knife and the double-edged stationary knife in preventing spread of ring rot.*

(Results given as 4-plot averages)

Treatment No	Type of Knife Used	Contamination of Knife with *C sepedonicum*	Type of Knife Disinfection	Average Stand per Plot	Per cent of Living Plants Showing Ring Rot
4	Rotary	+	$HgCl_2$ (0 2 per cent)	46 50	0.54
5	Rotary	+	$HgCl_2$ (0 2 per cent) + Vatsol[1]	45 50	0 55
7	Rotary	+	$HgCl_2$ (0 2 per cent) + Vatsol[2]	45 25	0 00
2	Rotary	+	None	28 00	75 89*
19	Double edged	+	$HgCl_2$ (0 2 per cent)[3]	43 50	0 00
20	Double edged	+	$HgCl_2$ (0 2 per cent) double flow	42 00	3 57*
21	Double edged	+	$HgCl_2$ (0 2 per cent) + Vatsol[1]	45 75	1 64
22	Double edged	+	$HgCl_2$ (0 2 per cent) + Vatsol[2]	44 75	0 00
18	Double edged	+	None	35 75	72 03*
1	Uncut tubers	—	—	46 50	0 54
Difference req for significance:					
5—per cent level				3 14	.[4]
1—per cent level				4 24	.

[1]2½ level teaspoons of Vatsol OT 85 per cent per 5 gallons solution

[2]5 level teaspoons of Vatsol OT 85 per cent per 5 gallons solution

[3]The flow rate for all double-edged knife treatments except treatment 20 was one quart per hour For treatment 20 the flow rate was doubled.

[4]See footnote 2, table 1 Test lots in which the number of diseased plants exceed expectation (odds 99 1) are starred (*)

TABLE 3—*The effect of platform-board contamination on the spread of ring rot in potatoes cut by a disinfected ($HgCl_2$ (0.2 per cent) rotary knife*

(*Results presented as 4-plot averages*)

Treatment No	Contamination of Rotary Knife with *C sepedonicum*	Knife Disinfection with (0 2 per cent) $HgCl_2$	Contamination of Platform Boards with *C sepedonicum*	Ave Stand per Plot	Per cent of Living Plants Showing Ring Rot
2	+	—	—	28 00	75 89*
4	+	+	—	46 50	0 54
6	—	+	+	42 75	2 34*
1	Uncut tubers	——	——	46 50	0.54
Difference req for significance					[1]
5—per cent level				3 82	...
1—per cent level				5 49	...

[1]As based on Poisson distribution (see footnote 2, table 1)
*=amount of ring rot excessive (odds 99 1)

(0 2 per cent mercuric chloride) rotary knife to the contaminated surface of the cutting table just adjacent to the knife When the seed pieces were cut by a contaminated but disinfected knife without exposure to platform-board contamination (treatment 4), control of the disease was complete A high percentage of ring rot (75.89 per cent) resulted when tubers were cut by a contaminated but non-disinfected knife. In treatment 6, in which tubers were cut by a disinfected knife and exposed to infection from the surface of the cutting table, a small amount of disease resulted (2 34 per cent) Assuming a Poisson distribution, this amount is excessive,—indicating incomplete control The reduction in stand in treatment 6 was non-significant

DISCUSSION

The results of this investigation indicate that, in spite of their respective limitations, a 0 2-per cent (1-500) solution of mercuric chloride or boiling water is probably the safest knife treatment for control of ring rot Cresol solutions in concentrations of 1 and 2 per cent appear to affect the resultant stands adversely, although the latter gave complete control of the disease Solutions of Roccal and Hyamine at the concentrations tested failed to control ring rot

The highly significant losses in stand following the use of treatments which failed to control the disease would seem to indicate that such losses were caused by *Corynebacterium sepedonicum.* However,

the inability of the ring-rot pathogen to cause seed-piece rotting or early death of the plants when introduced into healthy seed has been shown in previous studies (6). It would appear then that the tuber-inoculum used introduced *Erwinia carotovora* as well as *C. sepedonicum* into the seed pieces, thus creating a situation favorable to seed-piece rotting. Since the data show that knife disinfection prevented excessive loss in stand as well as controlling ring rot, it might be reasonably assumed that protection against both the soft-rotting and ring-rot pathogens was afforded.

In comparing the efficacy of the stationary double-edged knife with that of the power-driven rotary knife, it appears from this preliminary investigation that the former has considerable merit Although not designed to replace the rotary knife, the double-edged knife should be of value to growers who are interested in a simple and cheap way to cut their seed potatoes safely The addition of a surface tension reducing agent to the disinfectant or increasing the flow of the disinfectant did not improve upon the control obtained.

The danger of ring-rot infection from the surface of the cutting table or platform plates adjacent to the rotary knife does not appear to be too great when a 0.2-per cent solution of mercuric chloride is used to disinfect the knife. It appears probable that the surface film of disinfectant retained by the cut surface of a tuber may be sufficient to afford protection against invasion by the ring-rot organism Where boiling water is used, however, the danger may exist. It therefore seems advisable for cutters to avoid excessive contact with the platform boards or plates when cutting seed.

Summary

Tests using presumably ring-rot-free Red McClure seed potatoes in the San Luis Valley of Colorado in 1945 showed that boiling water and mercuric chloride solution (0 2 per cent) gave complete control of ring rot when used as rotary knife disinfectants. Solutions of Roccal (a mixture of alkyl dimethyl benzyl ammonium chlorides) in concentrations of 2, 1, and 0.5 per cent and Hyamine 1622 25 per cent (di-isobutyl phenoxy ethoxy ethyl dimethyl benzyl ammonium chloride) in concentrations of 0 2, 0 1, and 0 05 per cent failed to give adequate control of ring rot when used as rotary knife disinfectants. Cresol (Phenol coeff 5) in 2-per cent solution, although giving control, affected stand adversely The stand was also markedly reduced following the use of a 1-per cent Cresol solution which, in addition, failed to give complete control of ring rot. Both 1- and 2-per cent Cresol solutions, when used without knife contamination, also resulted in highly significant stand reductions.

A newly designed stationary and automatically disinfected cutting knife gave control of ring rot which compared favorably with that obtained by the use of the power-driven rotary knife when both knives were disinfected with 0 2-per cent mercuric chloride solution.

When mercuric chloride solution (0 2 per cent) was used as a cutting-knife disinfectant, only a relatively small amount of infection was obtained by exposing the cut surfaces of seed pieces to contaminated platform boards at the base of the knife.

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THE EFFECT OF NITROGEN, PHOSPHATE, POTASSIUM, AND pH ON THE YIELD OF RED McCLURE POTATOES AS DETERMINED BY SOIL ANALYSIS AND FERTILIZER APPLICATIONS[1,2]

WALTER C SPARKS AND JOHN G McLEAN

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For many years the method used for determining the fertilizer needs of a certain soil has been to analyze a sample of the soil and from this analysis and the previous cropping history recommend the type of fertilizer that should be used to obtain the best economic production of a certain crop Since most "quick-test" methods of soil analysis have been worked out on soils having an acid reaction, there has been some doubt regarding the value of these "quick-tests" when used

on alkaline soils where a large portion of the nutrients are in different chemical combination than those in acid soils For this reason an experiment was designed in which the yield of potatoes was used to determine the agreement between soil analysis and fertilizer applications

The purpose of this paper is to present the results of this experiment and show the agreement that existed between soil analysis and fertilizer applications

A field was divided into two parts, one for soil analysis where no fertilizer additions were made,—the other for the addition of fertilizers at known rates and compositions Each part was further divided into five blocks with each block containing ten plots A random soil sample of the top foot of soil was taken and analyzed from each of the 50 plots on one-half of the field while the plots on the other half received fertilizers at planting time by means of a fertilizer attachment on the potato planter Thus in part one the differences in yield were attributed to the variations in the amount of nutrients already present in the soil as found by soil analysis, whereas, in part two the differences in yield which existed, after the results were subjected to statistical analysis by the analysis of variance method, were attributed to the different amounts and kinds of nutrients added by fertilizer application

RESULTS

Nitrogen

In the fertilizer treatments which received neither phosphate nor potassium, the addition of nitrogen at the rate of 40 pounds per acre gave a non-significant yield increase of 13 sacks per acre, but in those treatments which received phosphate and potassium each at the rate of 40 pounds per acre, the addition of 40 pounds per acre of nitrogen gave a significant yield increase of 87 sacks per acre

The soil analysis data showed this same general trend, *i e*, when the amounts of P_2O_5 and K_2O found in the soil were 1 5 and 96 pounds per acre foot respectively and the amount of nitrogen found changed from 4 6 to 9 2 pounds per acre foot, the yield increase was only 14 sacks per acre, whereas, when the amounts of P_2O_5 and K_2O found to be present were 1 5 and 120 pounds per acre foot respectively and the amount of nitrogen found changed from 4 6 to 9 2 pounds per acre foot of soil, the difference in yield amounted to 51 sacks per acre

[1]The complete paper including data and figures will appear in the American Society for Horticultural Science Proceedings.

[2]Scientific Series Paper No 217, Colorado Agricultural Experiment Sta, Fort Collins, Colo

Phosphate

When neither nitrogen nor potassium was added but phosphate was added at the rate of 40 pounds per acre a non-significant yield increase of 23 sacks per acre resulted, but when nitrogen and potassium were applied at the rate of 40 pounds per acre the addition of 40 pounds per acre of nitrogen resulted in a significant yield increase of 102 sacks per acre

The results from the soil analysis plots were similar When the amounts of nitrogen and potassium were found to be present at a constant rate of 4 6 and 96 pounds per acre foot of soil respectively, the yield was found to increase 15 sacks per acre as the amount of phosphate found varied from 1 5 to 3 0 pounds per acre foot of soil With the amount of nitrogen and potassium found at the level of 4 6 and 120 pounds per acre foot respectively, a change in the amount of phosphate found to be present from 1 5 to 3 0 pounds per acre foot of soil resulted in an increase of 6 sacks per acre, but when the amount of phosphate found was 4 5 pounds per acre foot the yield increased by 27 sacks per acre

Potassium

An increase in the amount of potassium added from zero to 40 pounds per acre when no nitrogen or phosphate was applied resulted in a yield increase of 21 sacks per acre; but this same increase in potassium when nitrogen and phosphate at the rate of 40 pounds per acre were added gave a significant yield increase of 63 sacks per acre

The soil analysis plots showed that very little change in yield occurred when nitrogen and phosphate were found present in the soil at the rate of 4 6 and 3 0 pounds per acre foot and the amount of potassium found present in the soil varied from 72 to 168 pounds per acre foot of soil But when nitrogen and phosphate found to be present at a constant level of 9 2 and 1 5 pounds per acre foot respectively, a change from 120 to 144 pounds per acre foot in the amount of potassium found to be present in the soil resulted in a yield increase of 33 sacks per acre

pH

As the pH increased from 8 0 to 9 2, a decrease in yield from 189 8 to 151 5 sacks per acre was experienced.

A close relationship was found to exist between the results obtained by soil analysis and those obtained when fertilizers were applied to the soil This is true in the case of each of the three elements.

WEIGHT LOSS OF POTATOES STORED IN VARIOUS CONTAINERS

E K ALBAN[1] AND E B TUSSING,
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In the past few years the trend in potato marketing has been to consumer type packages, both paper and net bags. Many state laws require consumer packages to be marked with the net weight In Ohio, city ordinances require that packages marked with net weight must be up to weight when retailed. City weight sealers are constantly checking weights. It is necessary to add sufficient tubers at the time of packing to compensate for shrinkage in order to maintain the weight above the minimum marked on the package for a period after delivery The kind of container, length of storage period, temperature and humidity of the storage, method of handling, all enter into the weight loss that may occur Because of the increased use of consumer packages it seemed advisable to determine weight losses to be expected under various conditions

Katahdin potatoes harvested on the 25th of September, 1945, were held in common storage until the 27th of October, 1945 These tubers were packed on the 28th of October in 10-pound lots for each treatment or container Two types of containers were used, a two-walled kraft paper bag of 50-60 pound weight and a mesh bag commonly used for packing potatoes, onions and oranges Each bag was numbered and the weight in grams of each bag recorded. Five lots of each treatment were placed in room temperature storage (60-80 degrees F) and five were placed in cold storage (35-45 degrees F). The weekly weight loss of each bag was recorded to the nearest gram and the percentage loss calculated In addition tubers were waxed with an emulsion Brytene 489 A and another lot treated with a paraffin emulsion containing 2 per cent ethyl ester of naphthaleneacetic acid. Five bags of each lot were placed at the two storage temperatures. These treatments were made in an effort to inhibit sprouting as well as to reduce weight loss

In table 1 is shown the accumulative percentage weight loss of each treatment held at room and cold storage temperatures

From the table it is seen that cold storage lots lost only about one-half as much as the corresponding lots held at room temperature This was true, of course, only during the first eight weeks, before the sprouting of tubers at room temperature increased the difference. The dif-

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[1]Instructor and Extension Horticulturist

TABLE 1 *Accumulative per cent weight loss of Katahdin tubers following treatment and storage in various containers at room temperature and in cold storage**

TREATMENT	ROOM TEMPERATURE												
	November 1945					December 1945				January 1946			
	4	11	18	25	2	9	16	23	30	6	13	20	27
Net bag	1 2	1 9	2 5	3 2	3 9	4 8	5.6	6 4	7 4	8 6	10 0	11 6	13 3
Net bag and Brytene 489A	1 4	2 1	2 8	3.5	4.3	5 2	6 0	6 8	7 7	8 7	10 1	11 5	13 0
Paper bag	1 2	1 7	2 3	2 8	3 3	4 0	4 6	5 3	6 0	6 8	7.8	9 2	10 7
Paper bag and Brytene 489A	1 1	1 6	2 2	2 7	3 3	3 9	4 6	5 4	6 1	6 8	7.4	8 1	9 2
Paper bag and wax and ENA†	1 4	2 2	2 9	3 5	4 2	4 9	6 2			Discarded			
	COLD STORAGE												
Net bag	5	8	1 2	1 5	1 8	2 1	2 4	2 7	3 0	3 4	3 8	4 1	4 5
Paper bag	5	.8	1 2	1 4	1 7	1 9	2 2	2 4	2 6	2 8	2.9	3 1	3 2
Paper bag and Brytene 489A	5	8	1 1	1 3	1 6	1 9	2 1	2 4	2 6	2 9	3 0	3 2	3 3
Paper bag and wax and ENA	6	1 1	1 4	1 9	2 2	2 5	2 7	3 3	3 7	4 1	4 4	4 7	5 1

* Average of five lots from each treatment   † Ethyl Napthaleneacetate 2 0 per cent

ference between the two types of containers although not so great, show that the paper bag is superior to the net one in reducing weight loss The wax emulsion, Brytene 489 A, used on tubers stored at room temperature,—both in net and paper bags,—reduced weight loss compared with the untreated tubers in the same type bags The paraffin wax, plus 2 per cent ethyl ester of naphthaleneacetate caused a breakdown of tubers held at room temperature within eight weeks and showed the greatest weight loss of any treatment In cold storage, the breakdown was rapid at the end of 13 weeks

Based on a practice of packing 15 5 pounds gross weight in a 15-pound paper bag it would be necessary for the package to reach the consumer before the end of the fifth week if stored at room temperature, and within 13 weeks if stored in cold storage If freshly dug potatoes were packed, the time limit would no doubt be shortened

SECTIONAL NOTES

CALIFORNIA

We have just completed harvesting of the potatoes in the floor of the valley and will begin the harvesting of approximately 3,000 acres in the mountains in what we call the Tehachapi district within 2 or 3 weeks' time.

As of the 2d of July when the Market News Service closed its daily reports on Kern County Irish potato marketing, we had shipped 25,711 cars and the Government has purchased an equivalent of 9,761 cars This makes a total carload equivalent of approximately 35,472 cars Some of these cars as reported, were shipped from four different points in Tulare County just north of Kern County

The total loading until the 2d of July from Tulare County would be slightly less than 1,000 cars leaving carload equivalents in Kern County of roughly 34,470 cars

The majority of the potatoes purchased by the Federal Government was sold for the production of alcohol (July 10) —M A LINDSAY

COLORADO

As has been usual for the past 10 years, it appears that there will be another increase in the acreage entered for certification this year, which shows that the demand for Colorado certified seed is constantly increasing. The quality is also rapidly improving, as the result of a large scale tuber indexing and tuber unit planning program The num-

ber of new attachments for the Iron-Age Planter, in which the tubers are cut and planted by the operator in one operation, has tripled this year.

Airplane dusting is taking the country by storm this year. Most growers are using DDT, Copper and Sulphur, although, in cases where blight is not a problem, the copper is being omitted. The annual potato field day in the San Luis Valley will be held at the demonstration farm near Monte Vista on August 13 The Tri-State potato meeting, including Colorado, Wyoming, and Nebraska, will be held this year in Nebraska, sometime during the latter half of August Plans are not yet completed at this time. (July 15) —C H METZGER

IDAHO

The number of growers applying for certification of seed potatoes is about 23 per cent less than 1945 but the total acreage applied for is almost exactly the same as in 1945 On an average the seed fields are a week to ten days earlier than last year and those that are irrigated have prospects of an excellent crop The non-irrigated fields in southern Idaho are very dry and the crop on these will be light unless rain comes very soon

Commercial fields have better stands than last year, but rhizoctonia is very widespread and will probably have considerable effect in reducing yields. Early dying or wilt which has had considerable effect in reducing yields is beginning to appear in eastern Idaho about one month earlier than last year—due probably to the much higher temperatures. This may also have a material effect on total production.

The early potatoes in Southwestern Idaho are yielding well and a great many are going to the government under the price support program Many fields of early Russets in Southwestern Idaho have been plowed up because of leaf roll, and the production of early Russets in this area will probably be less than one-half that of 1945. (July 29) — JOHN R. ROBERTSON.

INDIANA

Looking back into the past history of potato production in Indiana we have never produced a surplus crop for the past fifty years or more. There are several reasons why this state has brought in potatoes from other areas to meet our requirements There has been an increase in population, the type of farming has changed and industry has taken over some of the good farming areas. The soils at one time were as nature

made them and there were but few insects or diseases present Possibly the low period was the 10 years from 1925 to 1935

According to data from the 1930 census figures we were growing about one-third the amounts required to meet the demand The average acre yield was low, the acreage was normal and the average per capita consumption was high Indiana produced 4½ millions of bushels in 1930 and consumed 11⅓ millions We were a good market for good potatoes but not all the markets received good potatoes It was the time for Indiana potato growers to meet the challenge

The soils that were nearing depletion of plant foods were improved through cover crops and commercial fertilizers The sunshine and the rain were given an opportunity of functioning when pest control methods were applied to allow a full leaf to grow where only a portion previously tried to do double duty The growers improved their cultural methods and used adapted varieties All these things brought about increased yields and improved quality

Although quite a few growers average 400 to 500 or more bushels per acre each year, of No. 1 quality potatoes, this is the exception but the state as a whole has advanced from the 75 bushels yield to an average of 150 bushels per acre In the meantime the average per capita consumption has dropped from 3½ to approximately 2 bushels per person and the acreage to about 33,000 acres Due to the increased yield, lower per capita consumption, and the untold numbers of bushels produced from the home gardens, it looks as if much of the Indiana markets for 1946 will contain more of their own growing than for many years (July 15) —W B Ward

Maine

To date no late blight has been reported in Aroostook County This sets a record for lateness, as in the last twenty years late blight has been more or less prevalent Aphids are just beginning to appear, mostly on fields which have not been sprayed with DDT A year ago early harvesting for seed plots was general on this date, but from present indications it is not expected to become general this year until the 19th of August The county has not suffered from lack of rains although we could stand more rain Everything, however, looks toward a crop somewhat larger than the 290 bushel per acre which was indicated in our report of the 10th of July

Farmers are still concerned that the crop may be somewhat larger than can be adequately stored The State Potato Committee is recommending a diversion program for field-run potatoes, purchases by PMA for export and a loan program for temporary storage as three factors which could help in assuring price support.

BIGGER POTATO CROPS POSSIBLE

If you control Potato Leaf-hoppers and Flea Beetles with Highly Effective Geigy DDT

IF YOU SPRAY, use GESAROL* AK 50, a 50% Geigy DDT composition.

IF YOU DUST, insist that GESAROL VD 50 be used in preparing the dust mixture you buy.

POTATO LEAFHOPPERS

Use 2 lbs. of GESAROL AK 50 per 100 gallons of water per acre or a 3% DDT dust (made from GESAROL VD 50) at 35 lbs. per acre Make three or four applications at about 10 day intervals starting when first leaf-hoppers appear.

POTATO FLEA BEETLES

Apply the same dosage as for potato leafhoppers using GESAROL AK 50 or dusts made from GESAROL VD 50. Watch for appearance of flea beetles and spray or dust before damage occurs.

* *Reg U.S. Pat. Off.*

GEIGY COMPANY, INC.
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Geigy
ORIGINATORS OF DDT INSECTICIDES

C. Chester Du Mond, Commissioner of Agriculture of New York, was the principal speaker at the Farm Bureau Field Day at the Experimental Farm, Presque Isle, on the 7th of August

Plans are being formulated by the Farm Labor Program to import about 5,000 people to assist during the harvesting period (Aug 5).—VERNE C. BEVERLY.

OREGON

Potato seed growers last year were alarmed by the sudden spread of leaf roll in many of their seed stocks We have always had leaf roll, but for some unexplained reason it is only lately that it has spread so that it has become a major menace The growers through a general seed organization known as the Oregon Seed Growers' League decided to ask the Legislature for a special potato disease control appropriation, but in order to show that they meant business, they passed the hat among thmselves and raised about $5,000 to start the work until a legislative appropriation could be obtained

With this money the Experiment Station hired Dr W. Harley English, who will work with J A Milbrath on this problem. Dr English was formerly assistant plant pathologist at the U. S D. A laboratories at Wenatchee, Washington, where he was working on the cause and control of storage diseases of fruits and vegetables He obtained both his B S and Ph D. degrees from Washington State College

In addition, growers of our largest potato-growing county, Klamath County, raised some money of their own and have hired a commercial entomologist, Joe Schuh, to work on insect vectors and their control. With the development of both types of work, we hope to know more about the most effective means of controlling leaf roll soon.

Early and efficient roguing of diseased plants is necessary to keep down the spread of disease This is particularly true of the virus diseases such as leaf roll, rugose, and mild mosaics which are transmitted by insect vectors Almost consistently the inspectors who have been doing field inspection work report that they have seen more early roguing being done this year than in any previous year. This is encouraging and should assist in holding down the spread of virus diseases. The potato crop in general in the Klamath Basin is making excellent growth. Generally, the stands are good and it appears that the crop is about a week in advance of the normal season Potatoes got off to a good start in most parts of the state, although in the Deschutes area, they are later than usual due to spring rains.

For years the potato seed certification work, as well as all other kinds of certification work in Oregon, has been directly under the super-

vision of the Extension Crop Spcialist In 1945 we inspected almost 100,000 acres of all kinds for sed certification, including over 5,000 acres of potatoes. This large volme of work justified the complete attention of one man, and Robert McCambridge, formerly Assistant County Agent in Klamath County has recently been appointed to take charge of all seed certification wrk in Oregon with the title of Extension Specialist in Seed Certifiation. Seed certification of potatoes as well as other crops is vested inthe Extension Service in Oregon by state law. (Aug 1) —E R. JACKMAN

SOUTH DAKOTA

At this writing the potato fiels in South Dakota are very good to excellent. Very little late blight has been found in any of the fields except in some table stock Early Ohos The condition of the Triumphs, Cobblers and Pontiacs is very good Vine growth has been exceptionally good with many fields now showng no row outline. Many cobbler fields look almost like fields of bucwheat Yields should be far above average but the indications now are that there will be some oversize in the certified fields Local new poatoes are now on the market and there will be certified fields harvestd during the last part of August

Vine killers are now being usec by several of the large operators so that the potatoes can cure in the fiells before being harvested One firm is using a weed burner which kills the vines completely The weather has been hot and dry in most sectins for the past few weeks and this has stopped the development of late blight, in fields which were not dusted or sprayed.

The chief field inspector, David Giese, is now making the second inspection of all certified fields. (Aug 2) —JOHN NOONAN

LONG ISLAND

The very general use of DDT on the potato fields has kept them almost entirely free from all detrimental insects This, together with a very favorable growing season, indicates that we will have a very good crop on Long Island; as good as 1945

The Cobblers are ripe, the Chippewas are ripening The Green Mountains are about as green as they ever have been It will be at least two weeks before any of them are ready to dig

Our growers are marketing their Cobblers as fast as they can It is necessary that they be dug and out of the way so our help will be available to handle the cauliflower crop when it matures in late September (Aug 1) —H R TALMAGE

ERRATUM

In the Sectional Notes from Cornia in the July issue, the statement is made "These figures mean average yield of approximately 285 sacks (10 lbs) per acre" This should read—"approximately 285 sacks (100 lbs) per acre."

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NEW BRUNSWICK, N. J

THE NEW SCAB-RESISTANT POTATOES, ONTARIO, SENECA AND CAYUGA

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AND

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Potato scab is one of the potato diseases that has been only partially controlled by any of the methods that have been used. It is well known that this disease is not troublesome in many sections where the soil is sufficiently acid. However, there are many other areas in which scab is one of the principal limiting factors in potato production. The use of seed treatments, long rotations, green manures, acidifying fertilizers, and heavy applications of commercial fertilizers, all have been of assistance in the control of potato scab, but still the disease causes considerable losses. There are large areas where scab-resistant varieties would make potato production more practicable and profitable The use of such a scab-resistant variety has already had a part in making practicable potato production in one important area, notably the use of

*In New York State a number of research assistants have had a large part in testing these potato seedlings They were successively Dr Phares Decker, now at Gainesville, Florida, Robert E. Wilkinson, Research Assistant in Plant Pathology, Dr. William F. Mai, Assistant Professor in Plant Pathology, and Wilson L Smith, Jr, Research Assistant in Plant Pathology; and, with respect to Fusarium wilt, C. S Tuthill, with the Federal Horticultural Board, and Charles A. Thomas, Research Assistant in Plant Pathology.

Russet Burbank in Idaho. Unfortunately this variety does not appear to be adapted to other areas where irrigation is not available. There are other reasons for seeking a good scab-resistant potato. Even in the areas where the soil is naturally sufficiently acid to inhibit the growth of the scab organism, it would be desirable to apply lime to improve the soil for the growth of other crops in the rotation, especially the clovers, alfalfa, and cauliflower. If a really good scab-resistant variety of potato were available this could be done practicably, thus improving the growth of the other crops in rotation and probably also of the potatoes through the general improvement of the fertility of the soil

When the national potato improvement program was being enlarged about 15 years ago, the workers in many states expressed an interest and a willingness to cooperate in the production and testing of scab-resistant varieties of potatoes. In New York State the first lot of seedlings bred for scab resistance was received from the workers in the United States Department of Agriculture in 1938. In the first year only sufficient tubers were received of each seedling to plant 2 units of five hills each Selections were made from these, and larger and more numerous tests were made in the succeeding years. By the end of 1944, the more promising seedlings had been tested in from 15 to 21 replicated field tests.

Four of these seedlings have been selected as promising All have a high degree of scab resistance. They also have more resistance to late blight than most of the common commercial varieties. All of them are more resistant to the wilt disease caused by *Fusarium solani* (Mart.) App and Wr. var. *eumartii* (Carp.) Wr, than the Rural potatoes commonly grown in western New York. All have given yields that compare favorably with the commercial varieties commonly grown, particularly of No. 1 salable potatoes on soils seriously infested with the scab organism. In 1945, with rather severe leafhopper infestation, they have appeared to show more than average injury from the attacks of this insect With the new insecticides that are becoming available, it is hoped that this insect may be easily kept under control

One of these seedlings (528-118) has also been selected for propagation in Michigan and named Menominee by Wheeler, Stevenson, and Moore.[1] This seedling has yielded well in New York and shown a high degree of scab resistance. Its principal defects under New York conditions have been its roughness and a tendency to produce under some conditions a high percentage of tubers affected with growth cracks.

[1]Wheeler, E J, F J. Stevenson, and H C. Moore The Menominee potato: a new variety resistant to common scab and blight. Amer Potato Jour 21(11): 305-311, 1944.

The other three seedling varieties have some undesirable characters also, so that they cannot be recommended unreservedly. It is to be hoped that further breeding and selection will lead to varieties still more desirable. These seedling varieties are described at this time with the hope that they will find at least a temporary usefulness particularly in areas where scab is troublesome.

Of the four scab-resistant seedlings, Ontario (528-242) has been outstanding in yield. It has not only been high in total yield, but has averaged a high percentage of tubers of Number 1 size and a high net yield after culls have been removed. It is a very late-maturing potato and has an undesirable tendency under some conditions to form sprouts at the bud end of tubers leading to the formation of secondary tubers.

Description of Ontario

Plants medium to large, erect, and spreading, stems medium size (average diameter 9.4 mm.),[2] slightly angled; nodes slightly swollen, green; internodes slightly pigmented (Salaman's RP 1); wings straight, green, stipules very large, green, glabrous; leaves long and broad (25 x 15 cm.), midrib green and scantily pubescent, primary leaflets intermediate, green, 4 pairs, the fourth pair often smaller, ovate, mean length 68.5 ± 1.7 mm (2.7 inches), mean width 40.7 ± .8 mm. (1.6 inches), index 59.7 ± .7; petioles green, secondary leaflets variable in number (average number 11), mostly attached to midrib between primary leaflets or at the base of petioles of primary leaflets, rare on petioles of primary leaflets except tip leaflet petiole, inflorescence simple or compound; leafy bracts rare; peduncles long (average 6.8 ± .3 cm.), leaf on peduncle not uncommon, green, medium pubescent; pedicels medium length (average 6.9 mm.), green, medium pubescent.

Flowers,—calyx lobe tips long and slender, very slightly pigmented, sparse pubescence; corolla small (2.9 cm.), pale lilac or pale lobelia violet in center of each petal, white at the edges; anthers empire yellow; pollen medium to poor, style straight or curved; stigma semi-globose, three lobed, green.

Tubers oblong, mean length 83.73 ± 1.12 mm. (3.30 inches), mean width 75.80 ± .65 mm. (2.98 inches), mean thickness 58.03 ± .55 mm (2.28 inches); indexes, width to length 91.80 ± 1.20, thickness to width 76.80 ± .68, thickness to length 70.5 ± 1.15; skin smooth, self-colored, dark creamy buff; eyes shallow except at bud end which is sometimes sunken, same color as skin but turning pink or

[2]Measurements were made on 25 or more specimens, except that in the cases of tubers, 100 were measured. Where errors are indicated they are standard errors.

purple on exposure to light; eyebrows medium long, curved, rather indefinite; flesh white; sprouts white; very late maturity.

Ontario is a selection from the same cross as Menominee, *i e.* Richter's Jubel and U. S. D. A. Seedling 44537, both scab-resistant

The other two seedlings selected as having commercial possibilities were both from the cross of Hindenburg and Katahdin. Hindenburg is a German variety with good scab resistance but not adapted to growing conditions in this country.

One of these, U. S. D. A Seedling 627-235, which has been named Seneca, has given yields only slightly less than Menominee and it has the same resistance to scab. The tubers are longer in proportion to width and thickness than those of Menominee and in our tests have not been so rough nor so likely to develop growth cracks. The tubers are slightly yellow in flesh color and they have a slight flavor that appears desirable to some persons

Description of Seneca

Plants medium large (average height 22 5 inches), spreading, stems medium thick (10 83 ± 23 mm) slightly angled; nodes slightly swollen, green, internodes green; wings straight, green; stipules large green, glabrous; leaves medium size (24 x 16 cm.); midrib green, very scantily pubescent; primary leaflets close, green, 4 pairs, ovate, medium large. mean length 75.8 ± .2 mm. (2.98 inches), mean width 44 9 ± 1 0 mm. (1 77 inches), index 59 38 ± 87; petioles green; secondary leaflets numerous (average number 17.8), on midrib between primary leaflets and on primary leaflet petioles (1-4), tertiary leaflets (smaller size) medium in number (average number 9); inflorescence mostly a simple cyme; leafy bracts few (average number 2.9); peduncles, mean length 11.7 ± .5 cm., very few scattered hairs, green, with 0 - 3 leaves; pedicle length 7.3 ± .21 mm, increasingly pubescent toward calyx.

Flowers,—calyx lobe tips about 10 mm. long, green or very slightly pigmented; corolla medium size (about 34 9 mm), color pale lobelia violet, white at tips, anthers wax yellow; pollen abundant; style straight in young flowers, becoming curved with age; stigma subglobose, multilobed, green.

Tubers round to slightly elongated, medium thick, mean length 80.72 ± .89 mm. (3.18 inches); mean width 75.09 ± .68 mm. (2.96 inches), mean thickness 55 79 ± 31 mm. (2.19 inches); indexes, width to length 93.58 ± .99; thickness to width 74.56 ± .76. and thickness to length 69 60 ± 85; skin slightly russeted, self-colored, cream buff;

eyes medium depth, same color as skin; eyebrows long slightly curved, prominent; flesh very slightly yellow; sprouts when developed in the dark, very faintly pink at base; maturity late.

The other seedling from the same cross, number 627-126, has been named Cayuga. The tubers have a very much russeted or scaly skin with very shallow eyes It is white-fleshed and stays white after cooking. It has a high specific gravity and good quality. Its worst fault appears to be that it sets a few too many tubers that may not all reach market size especially under unfavorable conditions

Description of Cayuga

Plants of medium size, spreading, becoming prostrate with age; stems slender to medium thickness (average 7 9 mm.), slightly angled; nodes slightly swollen, green, internodes green, wings straight, green; stipules medium size (average 21 mm.), green, glabrous, leaves medium size (21 x 14 cm); midrib green and very scantily pubescent; primary leaflets close, green, 4 pairs (occasionally 5), large ovate, mean length 61 92 ± 1 37 mm. (2 44 inches), mean width 36 99 ± 83 mm. (1 46 inches), index 59.87 ± .85; petioles green; secondary leaflets many on midrib between primary leaflets, at junction of midrib and petioles of primary leaflets, and on petioles of primary leaflets; tertiary leaflets medium in number; inflorescence branching, mostly simple; leafy bracts few (0-3) peduncle length medium (5 67 ± 28 cm.), scantily pubescent; pedicels 6.15 ± .16 mm, green, medium pubescent.

Flowers,—calyx lobe tips long and slender, very slightly or not pigmented, pubescent; corolla medium size, 30-32 mm. in diameter, color white to pale bluish lavender with white around the edges; anthers apricot yellow; pollen abundant, good quality; style straight, stigma 3-lobed, semi-globose, green.

Tubers flattened egg-shaped, mean length 89.24 ± .93 mm. (3.51 inches) mean width 74.80 ± 54 mm. (2.94 inches), mean thickness 56 89 ± .46 mm (2.24 inches); indexes, width to length 84.58 ± 1 01, thickness to width 76 26 ± 62, thickness to length 64 31 ± .77; skin heavily russeted to scaly, self-colored, light brown; eyes shallow, same color as skin, eyebrows not prominent, straight or slightly curved; flesh white; sprouts white in dark or slightly colored in subdued light; maturity medium late.

These four seedling varieties, with standard varieties as checks, have been grown in from 15 to 21 comparative tests giving average total yields as shown in table 1 The plots usually consisted of 25 or 30 hills each, but in a few cases of 100 hills, and each variety was replicated four or more times. It is difficult, however, to make a satisfactory

TABLE I.—*Total yield of four scab-resistant potato varieties in comparison with three standard varieties, in bushels per acre, from 1939 to 1944, at various test farms.*

Varieties	Curtis 1939	Curtis 1940	Robson 1940	Motz 1940	Dunn 1940	Curtis 1941	Schuler 1941	Robson 1941	Dunn 1941
Ontario	.	266	...	...	...	389	514	211	...
Cayuga	...	319	258	408	328	370	469	214	318
Menominee	412	300	307	353	330	368	425	205	253
Seneca	384	288	285	408	281	316	420	201	256
Sebago	...	291	304	.	316	338	462	170	302
Rural*	...	...	313	...	342	332	345	141	352
Katahdin	314	285	329	487	287	374	559	262	371
	Toan 1941	**Curtis 1942**	**Dunn 1942**	**Robson 1942**	**Robson 1943**	**Rockerfeller 1943**	**Curtis 1943**	**Dunn No 1 1943**	**Dunn No 2 1943**
Ontario	...	389	385	252	385	422	344	253	287
Cayuga	385	310	451	224	270	347	313	231	251
Menominee	402	204	287	165	367	.	..	230	184
Seneca	347	221	337	130	307	339	226	204	245
Sebago	. .	283	476	...	376	374	359	285	251
Rural*	...	181	424	172	320	314	232	264	238
Katahdin	. .	352	385	251	355	287	286	308	267

	Dunn 1944	Rockerfeller 1944	Crounce 1944	Average Total Yields as Compared with Seneca **
Ontario	363	454	445	372.2
Cayuga	340	359	271	326.5
Menominee	331	454	...	306.9
Seneca	301	333	251	289.5
Sebago	330	380	...	335.6
Rural*	392	367	...	309.9
Katahdin	...	407	268	342.2
				34.7

*Smooth Rural was used in most of these tests but Russet Rural was substituted in three tests and grown in six others in addition to Smooth Rural.

**To obtain a relative figure influenced as little as possible by different years and fields in which the different varieties were grown, the gains or losses in yields as compared with Seneca were averaged. These average net gains were added to the average yield of Seneca to give relative yields of the respective varieties as shown.

summary of these yields. At first only part of these were grown in replicated tests Later there have been irregularities for other reasons. A straight average of these yields would therefore favor those varieties which happened to be grown in the high-yielding fields and years. To eliminate such variations as far as possible, Seneca is used as a standard, as it was the only variety grown in every test. The differences in yield between Seneca and the other varieties were taken for each test and these differences averaged These gains in yield over Seneca were then added to the average yield of Seneca to give the relative yields of the different varieties as shown in tables 1 and 4 There has been much fluctuation in the relative yields in the different fields but Ontario seems to be well out in front with significant gains in yield over all the other varieties, except that the gain over Katahdin is of doubtful significance Cayuga, Sebago, and Katahdin seem to fall in about the same class, and Rural, Menominee, and Seneca in a lower class.

Figures are not available for the tubers grading in No. 1 size for all of these tests, but certain tests have been selected in which all these varieties were grown in the same test and graded over the standard chain (table 2). The percentages of tubers grading No. 1 size seem to be significantly different only for Cayuga, on the average. These percentages of No. 1 size tubers have been used in table 4 to compute the relative yields of No 1 size potatoes for the several varieties. With respect to the production of No. 1 size potatoes, Ontario is still leading, but Cayuga has lost some ground. This leaves Katahdin and Sebago as probably better in yield than the other scab-resistant varieties and the Rurals. The Rurals and the scab-resistant varieties except Ontario seem to yield about alike where scab is not a problem.

Various types of scab readings have been taken in these tests but of greatest significance to the commercial grower of potatoes, we believe, are the numbers of tubers that must be thrown out as culls because of deep scab pits. Tests have been selected where all these varieties occurred and where the scab was serious enough to make a relatively severe test. Although all of the tests were planted on soil that was believed to be seriously infested with the scab organism, some soils did not give as severe a test as was expected, and on some fields the scab seemed to become less severe when the tests were continued in the same field for a series of years. The results of seven tests, table 3, show a marked difference in the percentage of culls among the four new scab-resistant varieties and the three standard sorts. The least difference for significance calculated from the whole table, can be regarded as only a rough approximation since the variability among the scab-resistant

TABLE 2.—*Percentages of tubers grading No 1 size.*

	Curtis 1941	Schuler 1941	Robson 1941	Curtis 1942	Robson 1943	Averages
Ontario	94 3	87 0	94 3	87 9	92 7	91 2
Cayuga	90 3	84.4	93.5	74.2	82 2	84.9
Menominee	93.2	91.1	95 1	76.5	95 1	90 2
Seneca	92.4	89 8	95 0	75 1	93 2	89 1
Sebago	90 8	92.4	98 2	80.9	89.1	90 3
Rural*	91.0	93.2	97.2	77.3	91.6	90.1
Katahdin	94.4	93 8	95 4	83 2	91 3	91 6
			Least significant difference			3.84

*Russet Rurals were used in some tests and Smooth Rurals in some and one test (Robson 1943) included both

TABLE 3.—*Percentages of potatoes grading as culls because of deep scab injury, in tests on scab-infested soil*

	Curtis 1941	Schuler 1941	Robson 1941	Curtis 1942	Robson 1943	Dunn 1943	Rockerfeller 1944	Average
Ontario	0.2	2.0	0.2	.3	.4	0	0	.44
Cayuga	0.2	0.2	0	.8	0	.0	.0	.17
Menominee	1.4	1.2	.4	.4	3.4	.5	.2	1.07
Seneca	0.0	.2	.6	1.0	1.7	0	.4	.56
Sebago	4.2	5.8	8.6	3.7	18.0	14.0	14.8	9.87
Rural*	29.0	14.8	43.2	0.0	35.1	7.8	6.6	19.50
Katahdin	57.8	48.2	54.4	28.3	67.6	22.3	15.2	41.97
				Least significant difference				10.01
				Least significant difference among scab-resistant				.77
				Least significant difference among scab-susceptible				13.76

*Smooth and Russet Rurals are represented in this table in approximately equal proportions.

TABLE 4.—*Summary of relative total yields, No. 1 size, culls and net salable potatoes, in bushels per acre.*

	Relative Total Yields	Average Percentage Grading No. 1 Size	Computed Yield No 1 Size	Average Percentage Culls	Net Salable
Ontario	372.2	91 2	339.4	44	337.9
Cayuga	326.5	84.9	277.2	.17	276 7
Sebago	335.6	90.2	302 7	9 87	272 8
Menominee	306.9	89.1	273.4	1 07	270 5
Seneca	289.5	90 3	261.4	56	259 9
Rural*	309.9	90.1	279 2	19 50	224 8
Katahdin	342 2	91.6	313 2	41.97	181 9
Least significant differences	34 6	3 8	33 4	10 01 about 34.	

*Smooth Rurals were used in the majority of these tests but in 3 cases Russet Rurals were substituted and in six others they were included in addition to Smooth Rurals.

varieties with low percentages of culls is much less than among the susceptible varieties with high percentages of culls. There seems to be some doubt about the relative scabbiness of Rurals and Sebagoes, and properly so. In the first tests made, the Rurals had clearly more culls than the Sebagoes, but later some instances were found where the reverse was true.

These average percentages of culls obtained from table 3 have been carried over to table 4 and the effect of their removal has been shown in the column headed net salable potatoes, to show the results which could be expected when these potatoes are grown on soil severely infested with scab. In this column, Ontario has an outstanding lead. Cayuga, Sebago, Menominee, and Seneca are not greatly or significantly different. Rural and Katahdin have fallen behind due to the removal of the large numbers of culls. Sebago may have a higher place in this final column than it deserves since in several fields it has shown more culls than has Rural and its use in scabby locations could not be recommended except on a trial basis.

Reference has previously been made to the prevalence of growth cracks and knobs in some varieties and the consequent reduction in value as commercial potatoes. Only a limited amount of data are available on this point. Such data from tests including all the varieties compared in this paper have been collected in table 5. It is noticeable that there has been great variation in this respect in different fields and different years, but in the average the variety Menominee appears to be materially worse in this respect than the other varieties included. Ontario and Sebago were lowest in percentages of tubers showing growth cracks, though not significantly lower than some of the others. Katahdin was included although data for it in one field was not available, so that the average given for this variety may be less reliable than for the others.

One series of tests with these seedlings and standard varieties was made on soil infested with the fungus *Fusarium solani* (Mart) App and Wr. var. *eumartii* (Carp.) Wr., the cause of one of the wilt diseases of potato, locally known as Z disease. The data available for these seedlings and some standard varieties, presented in table 6, show rather large fluctuations. For this reason and because there was some change in the varieties tested each year, the results have been summarized by averaging for each variety the differences between its annual percentage wilt and the annual averages of the three standard varieties that were planted in all tests. This summary makes it clear that the Smooth (Pioneer) and Russet Rurals are outstandingly susceptible to this disease. Menominee and Ontario are at the other end of the scale with

TABLE 5—*Percentages of tubers showing growth cracks or knobs in the tests indicated*

Varieties	Robson 1941	Schuler 1941	Curtis 1941	Curtis 1942	Robson 1943	Dunn 1944	Rockerfeller 1944	Average
Ontario	0	5.2	.4	.5	7	4 8	5 6	2 46
Cayuga	4 4	9 0	6	8	1.3	7 7	8 4	5 49
Menominee	4 0	22 2	5.1	1 7	18.2	43 0	16 4	15.80
Seneca	2 8	13 8	2.8	1 3	12 2	9 6	5 0	6 79
Sebago	4	5.6	8	1 0	3 4	2 4	3 8	2 49
Rural*	3 2	28.4	3 4	9	5 4	15 5	12 6	9 91
Katahdin	.4	14.0	1.4	1 3	5 2	11 9**	2 0	5 17
Least significant difference								5 91

*Results for both Smooth and Russet Rurals are included

**Figure supplied by the method of supplying missing data No reading was available for Katahdins in that field

TABLE 6.—*Percentages of potato tubers infected with the wilt organism Fusarium solani var. eumartii in a series of replicated tests.*

Variety	1939	1940	1941	1942	1943 No. 1	1943 No. 2	1944	Average Deviation*	Relative Infection
Menominee		0.3	0.5	2.5	0.7	2.2	2.2	—9.75	1.26
Ontario				6.0	1.5	4.0	4.5	—9.73	1.28
Seneca		0.0	0.0	5.7	2.3	6.5	10.8	—6.98	4.03
Houma		0.5	0.5	3.0	5.5	8.5		—5.94	5.07
Earlaine No. 2				7.0	10.3	6.5	8.9	—5.55	5.46
Cayuga		1.8	4.5	9.0	4.3	8.0	8.3	—5.22	5.79
Sequoia			4.8	4.5	5.5	9.5		—4.25	6.76
Pontiac	4.6	9.3	1.3	5.2	11.5	6.7	8.9	—4.23	6.78
Chippewa	1.2	0.5	0.0	10.5	11.3	10.0		—4.02	6.99
Katahdin	5.0	0.3	0.8	9.7	13.2	10.7		—2.98	8.03
Sebago	11.3	0.5	1.4	10.7	7.8	5.5	21.3	—2.66	8.35
Green Mt.	6.9	3.5	10.8	5.0	9.8	15.7		— .90	10.11
Russet Rural	12.2	5.3	19.9	13.7		19.0		5.52	16.53
Pioneer Rural	13.8	9.3	15.0	12.5	26.0	20.2	28.4	6.87	17.88
Least significant differences								4.69	4.69
Average of standard varieties									
Pontiac, Smooth Rural, Sebago	9.9	6.4	5.9	9.5	15.1	10.8	19.5	Average for 7 tests	11.01

*To avoid seasonal variations, deviations of each variety from the yearly average of the three standard varieties were averaged. The average deviation of each variety was subtracted from or added to the general average of the standard varieties to give the relative percentages of infection for the several varieties as shown in the last column

other varieties intermediate. No finer distinctions can be drawn though it appears that there are differences large enough to be commercially important as well as statistically significant in this respect

Several times in the course of these tests, observations have been made indicating that these seedling varieties had some blight resistance. In 1943 on the Curtis farm a record was made of the approximate severity of the late blight on the tops late in the season and a count was made of the blight rot in the tubers at harvest (table 7) Of course, this resistance might break down when and if these potatoes are grown on a large scale through the development of especially adapted strains of the fungus.

TABLE 7.—*Susceptibility of seedlings to blight infection of foliage and tubers*

Variety	Rating of Severity of Foliage Infection Replication				Percentage of Tubers Showing Blight Rot
	1	2	3	4	
Ontario	1*	1	1	1	0.0
Cayuga	1	1	1	1	0.0
Seneca	1	1	1	1	0.0
Sebago	1	3	1	2	1.5
Smooth Rural	1	2	2	2	4.5
Russet Rural	1	2	3	2	4.7
Katahdin	2	3	3	3	6.7
Significant difference at 5 per cent level					2.9

*1=few scattered blight lesions
2=numerous blight lesions
3=innumerable blight lesions plus death of entire leaves and shoots

TABLE 8.—*Comparison of length of growing season of some varieties of potatoes, in days from planting to maturity*

Variety	Years 1942	1943	1944
Cayuga	85	100-106	Cobbler 100
Katahdin	90	100-106	Houma 100
Seneca	100	over 116	Cayuga 110
Sebago	100	over 116	Katahdin 110
Menominee	over 100	over 116	Seneca 120
Ontario	over 100	over 116	Green Mts 120
Smooth Rural		over 116	Smooth Rural 120
Russet Rural		over 116	Ontario 120+

As to time of maturity, table 8, Cayuga seems to be definitely later than Houma but about with Katahdin Seneca is a little later and about with Rural and Sebago. Menominee and Ontario are still later and in our experience have usually only been killed by frost

No results of expert cooking tests are available on these varieties at present, although considerable amateur sampling has been done with the usual differences of opinion. All are at least fair to good in this respect. Cayuga was retained especially because it is so smooth that there is little loss in preparation. It cooks white and stays white after cooking It has shown a high specific gravity in a limited number of tests and has good texture. Ontario, although not so white as Cayuga, has appeared satisfactory Seneca is probably not quite so smooth as either Cayuga or Ontario, but is better in this respect than Menominee. It has a slight yellowish tint when cooked and a little more flavor. It was judged to be desirable as a baked potato.

Conclusion

Of the scab-resistant seedlings received from the U. S. D. A. breeding station in Maine in 1938, four were selected as having some commercial possibilities One of these, Menominee, has already been described from Michigan. Three others are described herein. Ontario has given the highest yields of these three It is highly scab-resistant and also has some resistance to late blight and Fusarium wilt. It has fair to good cooking quality, but is not so high in specific gravity as Cayuga

Cayuga has not been so high in yield as Ontario but has been comparable in our tests with Rural and Sebago. It also does not produce so high a percentage of No. 1 size potatoes as the other scab-resistant seedling varieties or the standard varieties, averaging 85 per cent in our tests as compared with about 90 per cent for the others. It is highly scab-resistant and possesses some resistance to late blight and Fusarium wilt. Cayuga seems to have the best cooking quality of these scab-resistant seedling varieties. It has high specific gravity, cooks white and mealy, and remains white after cooking. It ripens with Katahdin

Seneca has not been so high in total yield as Ontario, or even Cayuga, but it produces a higher percentage of No. 1 size potatoes than Cayuga so that the comparison in the production of marketable potatoes is not very unfavorable. It is intermediate in ripening between Cayuga and Ontario and about with Rural. It has some resistance to late blight and wilt, but is not so resistant to wilt as is Ontario.

CORKY RINGSPOT OF POTATOES IN FLORIDA

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Corky ringspot of potato tubers[1] which was described and illustrated by Atanasoff (2) as internal brown spot or sprain and by Appel (1) as pfropfenbildung was observed at Hastings. Florida, for the first time in crops dug during April, 1946 Tubers affected with the disease were first found at potato packing plants by inspectors of the Federal-State Inspection Service, and samples were brought to the Potato Laboratory for identification of the disease.

The disease was observed in potatoes grown on 3 farms in which the predominant soil types are Bladen fine sand and loamy fine sand. It occurred in fields which have been planted to potatoes every year for over 25 years and in one field in which cabbage had been grown for several years prior to planting it to potatoes in 1946. According to reports of the Federal-State Inspection Service, the disease was present in U. S. No. 1 graded potatoes from 2 of the farms to the extent of 2 to 8 per cent in 2 carloads, 2 to 17 per cent in 7 carloads and a trace in one carload. These reports do not include spotted tubers which were dumped, or affected ones which were packed and shipped as a utility grade. One grower reported more than 50 per cent loss from the disease in one field. No records were made of the amount of the disease on the third farm as the potatoes were not inspected when packed for shipment.

According to Atanasoff (2), corky ringspot is generally distributed in European countries, the Dutch Indies and South Africa, and he also stated that it occurred in numerous localities in the United States and Canada However, it is doubtful that it has been found previously in the United States, certainly not under natural conditions, and probably not at all if the "sprain" found in Irish Cobbler tubers grown in the greenhouse in Wisconsin is something different (7). It is not the same disease as physiological internal necrosis described by Larson and Albert (5). Corky ringspot is known by many names in European countries. It is called kringerigheid in Holland; eisen, buntfleckigheit and

[1]This name was suggested by Dr. Karl H. Fernow, Cornell University, Ithaca, New York. Dr Fernow saw specimens of the disease while in Germany in 1933 and also examined specimens of affected tubers sent to him from Hastings, Florida, in 1946.

pfropfenbildung in Germany; maladie des tâches en couronne in France and spraing and internal rust spot in England (2).

Atanasoff (2) stated that the disease occurred constantly on certain heavily manured sandy soils and reclaimed muck lands and that it had never been found on heavy clay soils. In Holland, it is considered of minor economic importance, but it has caused losses amounting to over 50 per cent of the tubers in some fields In some parts of the Dutch East Indies, 80 to 100 per cent of the potatoes were reported to be affected with the disease.

SYMPTOMS

Symptoms of the disease in Florida-grown potatoes consist of brown, concentric rings or sections of rings on the surface of tubers (Fig. 1, A and B). There is considerable cracking of the skin in the rings. Some tubers in affected crops also showed growth cracks and shallow, irregularly-shaped, corky depressions. The flesh beneath the surface rings is brown in affected areas, resembling the discoloration caused by late blight. This discoloration may also be apparent on the surface of affected tubers The same ring-like pattern on the surface of a potato is evident in the affected flesh (Fig 1, C and D). Brown, corky areas are also scattered throughout the flesh of severely affected potatoes

CAUSE AND TRANSMISSION

Much of the literature on the cause of corky ringspot is contradictory Quanjer (6) classified the disease as virus. Atanasoff (2) disproved the conclusions reached by earlier workers that it was caused by bacteria. He transmitted the disease to healthy tubers by grafting portions of diseased tubers on them and concluded that the causal agent was a living organism and entered from without. Many of the Dutch and English workers concluded that the disease is not transmissible in the tubers and blame it on environmental factors and condition of the soil. Atanasoff (2) and Botjes and Quanjer (3) noted that varieties of potatoes differed in their susceptibility to the disease, and the latter listed Triumph as resistant.

At Hastings, no organism has grown from pieces of affected potatoes placed on potato dextrose agar in petri plates. Examinations have revealed a few nematodes in the brown, scurfy material taken from cracked rings on the surface of tubers. Small, round bodies which might be resting cells of a fungus have been found in sections made from brown, corky tissues near the surface of diseased potatoes. Brown

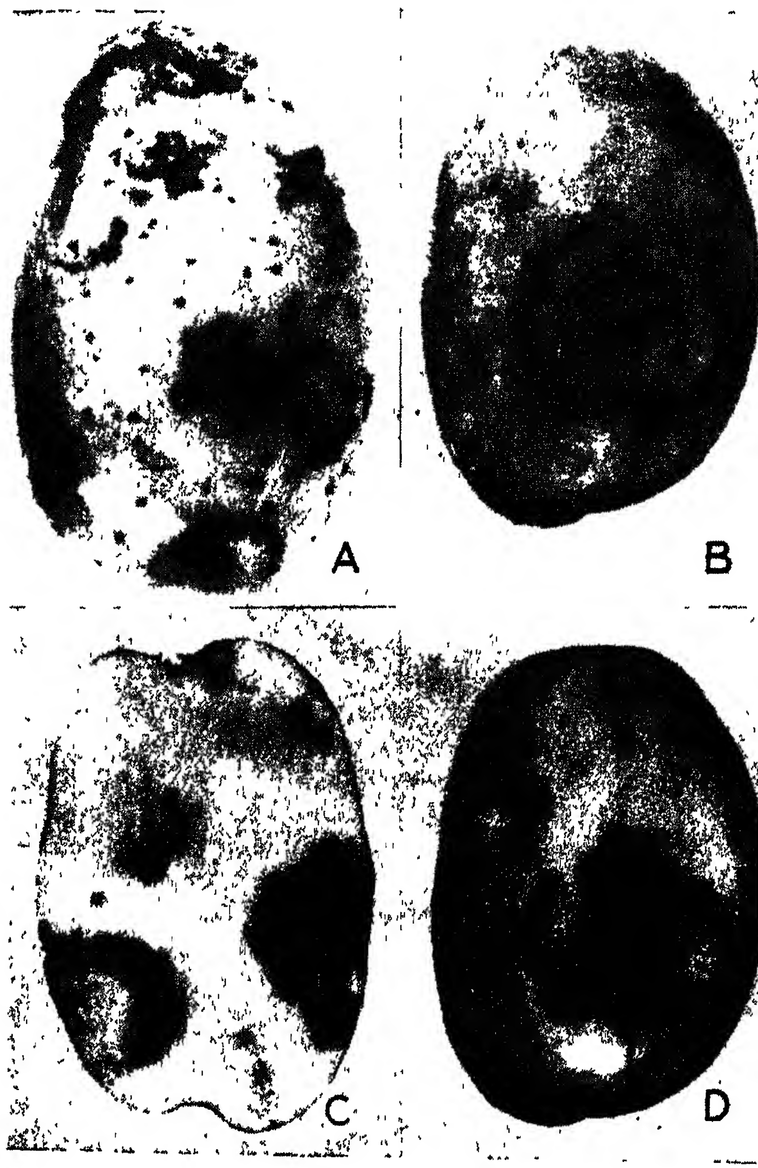

FIGURE 1.—Corky ringspot of potatoes. A. View of several lesions on the surface of a tuber. B Surface view of concentric rings of discolored and cracked area in a large lesion C, D Sectional views showing pattern of discolored tissues in the flesh of the same tuber shown in B.

masses of starch grains in affected tubers as noted by Kerling (4) were also seen.

CONCLUSIONS

This report on the occurrence of corky ringspot of potatoes in Florida is made to call attention to the trouble so that workers may be on the lookout for it in other parts of the country. Its sudden appearance in severe form in a few fields at Hastings, Florida, is mysterious Further information is needed on the cause, dissemination and control of the disease and its present distribution in North America.

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THE KILLING OF POTATO TOPS WITH CHEMICALS IN OREGON[1]

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There are many reasons for killing potato vines before they mature.

1. The crop may be dug and shipped early to take advantage of good markets, or harvested over an extended period to better meet labor shortages

2. Dependence on freezing or maturity of the vines is eliminated and consequently advantage may be taken of the good weather usually found in the fore part of the harvest season

[1]Based on a series of test demonstrations established throughout Oregon during fall of 1945 by the Oregon State College—Federal Cooperative Extension Service.

[2]Formerly Assistant Extension Specialist in Farm Crops, Oregon State College, Corvallis, Ore.

3 Most weeds are killed too, thus digging is made easier and cheaper and mechanical injury to the tubers is lessened.

4 In areas infested with late blight, all potato vines should be dead before the digger is moved into the field. Otherwise, tubers are often blighted and a severe loss may be experienced Any one waiting for freezes before digging in Oregon's blight area usually runs into winter rains Therefore, chemical killing is a practice employed by many. Any chemical toxic enough to kill plants will also deal death to the blight growth and spores with which it comes in contact, but even if the chemical does not come into direct contact with the blight organism, the death of the plant will result in the elimination of most of the blight and in making digging safe.

Type Chemicals To Use

All chemicals used to kill potato tops are severely caustic to plants They do not, however, damage unexposed tubers and at the rate applied, no soil residues carry over into the following year. Their effect on yield is not definitely known A fast kill is no doubt equal to a hard frost while a slow kill allows some tuber development between treatment and complete dying down of the tops

Digging may begin two days to two weeks after application of the material. For early markets where a feathered skin is not objectionable, harvest may be started 48 hours after treatment if a fast kill is obtained Where a set skin is desirable or blight is a hazard, it is necessary to wait one week after application if the vines die rapidly, and from 10 days to two weeks if a slower-acting material is used

Factors Affecting Kill

The rapidity of kill desired determines the material and dosage to use, and there are many factors affecting the speed with which the plants are killed.

1. Maturing, yellowing vines are killed more easily than green, vigorously growing tops

2. Smaller plants require less material than large ones

3. The larger, and greener the weeds, the more material one needs.

4. Low humidity and/or temperature at time of treatment is unfavorable, whether a spray or dust is being used

5. Varietal differences appear less important than the foregoing considerations In treating White Rose, Netted Gem (Russet Bur-

bank), and Burbank varieties, speed and completeness of kill seemed to be determined mostly by maturity and size of vine growth

Information on Chemicals and Their Application

The chemicals are applied in either spray or dust forms When used as a spray the kill is usually faster than when used as a dust. For good results, dusts should be applied in the morning when dew is on the plants or expected soon or when humidity is high Warm temperatures following application are important. *Dust is not generally recommended in eastern Oregon because of low humidity*

If a spray is used, it is only necessary to apply a sufficient amount to obtain leaf coverage. This will require from 100 and 200 gallons per acre with 125 to 150 gallons the average amount Most materials are mixed best by filling the spray tank one-half full of water, starting the agitator, adding the chemical and then filling the tank.

Three dust materials have merit for vine killing work:

Copper sulfate or bluestone is the slowest and least satisfactory of all materials tested but it will kill if the humidity is high and temperature warm. In addition, it is cheap and readily available. 40 to 50 pounds per acre is an average dosage.

Powdered calcium cyanamid when applied at 40 to 50 pounds per acre works well if climatic conditions are right. It, too, is inexpensive and has an added advantage in being a fertilizing material carrying 21 per cent nitrogen

Sinox 15 per cent dust, while the fastest acting of the dusts tried, is also dependent on humidity and temperature. It is used at the rate of 30 to 35 pounds per acre.

Here is information on sprays:

Ammonium thiocyanate is a salt to be applied at the rate of 40 to 50 pounds per acre in a spray solution It is not yet available in the Northwest. This material is somewhat corrosive and sprayers should be flushed well after use. It contains about 36 per cent nitrogen and 42 per cent sulfur, and is also valuable for its fertilizer effect.

Although not so dependable as other chemicals tried, copper sulfate may be used in a spray form as well as dust. Dosage remains the same, that is, 40 to 50 pounds of the bluestone per acre in enough water to give leaf coverage. Copper sulphate tends to corrode equipment, so a good flushing after making the applications is important.

A new product that has given good results as a vine killer is

Sinox General. This contains one of the dinitro compounds plus an emulsifier One to one and one-half or more quarts of it with two gallons of stove or Diesel oil per hundred gallons of water will be adequate Adding a few more gallons of oil might step up the penetrating value and toxicity of the solution.

Another good material is Dow Contact Herbicide which also contains one of the dinitro compounds, plus an emulsifier, a wetting agent, and oil. Mix this at the rate of one and one-half to two or more gallons per 100 gallons of water. Five to ten gallons of Diesel or stove oil may be added if desired to increase wetting and killing power

Two other common weed killers, ordinary Sinox and Dow Selective Herbicide, are often used and in trials have proved satisfactory but they are not considered equal to the Sinox General and Dow Contact because the latter two give superior coverage and kills.

Application Equipment

When sprays are used, equipment that evenly distributes the solution over the leaves and vines is necessary. Machines designed for potato spraying may require a reduction of pressure to avoid beating the vines down as this prevents the wetting of lower leaves. Weed control spray outfits utilizing booms equipped with fan-type nozzles can be used satisfactorily. The boom should be carried high enough to cover all parts of the potato vines as well as the weeds.

Vine killing dusts may be applied with any type of duster giving uniform coverage. Row crop dusters with hoods are often used because many potato growers find them available. The boom-type pea dusters with a hood or canvas drag give good results

For treatment of large acreages, experienced pilots in specially equipped airplanes can apply both dusts and sprays not only rapidly but uniformly.

SECTIONAL NOTES

CALIFORNIA

The growers of Kern County are at present harvesting 3,000 acres of potatoes produced in the mountains of Tehachapi. These are fairly well matured potatoes and in general are not marketed as early potatoes

It is too early to estimate what the growers will do in the way of acreage in 1947. It seems fairly certain, however, that nitrogen in the

ammonia sulphate form will be difficult to secure. In addition to the nitrogen supply, Federal regulations pertaining to a potato program may alter the potato situation in 1947. (Aug. 26).—M. A. LINDSAY

IDAHO

The condition of the Idaho potato crop appears very good "Early dying" or Fusarium wilt has developed about a month earlier this year than last and has progressed very rapidly because of the hot weather Some sections of Eastern Idaho are planning to start digging about the 1st of September, largely because the plants have matured as a result of this wilt Some sections are also reporting a lighter "set" than usual.

Our acreage of certified seed is approximately 900 acres larger than that of last year and the quality is very good as far as freedom from disease is concerned. The size and yield on non-irrigated land will be small due to lack of rain during the growing season. Some sections of north Idaho had frost in August, which will probably reduce yields of seed potatoes in those sections. (Aug. 29).—JOHN R. ROBERTSON.

INDIANA

In years past, we have never given much serious thought to the control of the late blight of the potato and thought it was a trouble that would never hit our Middle West. This year, however, as in last year, we had considerable damage from late blight and the climatic conditions throughout the entire growing season have been very favorable for this development. It has taught our growers one lesson and that is, if they are going to grow potatoes either in Indiana or elsewhere they will be wise to follow a very definite spray schedule program to control the various insects and diseases. They do not know what a toll these pests take from the potato crop until they have a definte check. We have found in Indiana that by controlling the insects alone we obtain an increase of approximately 125 bushels per acre, and when the blight is controlled, it will give another increase of 125 to possibly more than 300 bushels per acre, which certainly is a significant difference. The blight on the tomato is very serious this year and when that crop, along with our potato crop, has been damaged, it certainly is sickening to our folks.

In some of our preliminary checks comparing the Red Warba with the Triumph for early and medium early plantings, the Red Warba is outyielding the Triumph about two and a half to one Our final

checks will be made the latter part of September and the first two weeks in October. (Aug. 24).—W. B. WARD.

KENTUCKY

Our "first crop" is now history. Growing conditions were almost ideal, and the average yield of 200 bushels per acre of No. 1 tubers topped even the "record" crop of 1929. The quality was excellent, and the crop moved at a price so much better than the support price that no potatoes needed to be diverted.

Septoria was present and Phythophthora,—rare in Kentucky,—was reported here and there, but with apparently no tuber damage.

Using DDT instead of arsenicals, almost complete control of the black flea beetle was obtained, and the "vigor" was noted that other states have reported. It is possible that flea beetle injury creates conditions that contribute to Septoria damage, or that that injury itself is so often confused with "blight." (Sept. 3) —JOHN S GARDNER

MAINE

Aroostook County is looking forward to a tremendous crop of potatoes. Following a period of dry weather, the liberal rainfall that occurred about the 17th of August was in time to give a tremendous boost to the late varieties. Even most of the Irish Cobblers which had been sprayed with DDT were still in the stage of growth that could be greatly helped by rain

The Production Marketing Administration has just announced that loans will be made on potatoes in temporary storage. This means storage in which potatoes can safely be placed until the 15th of November, which should help a critical situation. Loans for potatoes in permanent storage have already been approved

More potatoes have been harvested early for seed than ever before in the history of the county. Many farmers have pulled tops to prevent virus spread, but many others have sprayed their tops in order to kill them before the winged aphids could transmit the disease from other fields. Sinox, Handy Killer, Dow 66 Improved and Cyanamid have been used liberally. This should result in a very high type of seed for the use of Aroostook growers next year No late blight has occurred in Aroostook this year It is now apparent that DDT has helped tremendously in increasing the yields. Many farmers are spraying a portion of their acreage with top killers so they may start harvesting operations without danger of causing rot, which so often results if potatoes are harvested when the tops are green. This is a progressive

program. Some reports of tuber cracking have been made. Top-killing may be one answer to this problem also.

Through the Farm Labor Program 3750 Canadian, 1000 Kentucky and 200 Arkansas workers will be brought into the county to assist in the harvesting operations (Sept. 5) —VERNE C BEVERLY.

NEW YORK

Generally speaking the crop in upstate New York looked good until the 15th of July Between that time and the 1st of August things began to happen in various parts of the territory. Blight began to develop in some sections and made severe inroads on small unprotected fields. Leafhoppers also became serious and caused considerable damage except on fields where DDT had been used. A third factor that affected the crop during that critical period was the dry weather that prevailed in certain areas Collectively, these conditions will have some effect on the total crop and experienced potato men now regard the August 1st estimate as too high for the upstate area However, it will be another month before the harvesting of the late crop will tell the final story.

Generally speaking, potatoes were pretty well cared for and DDT was used as an insecticide by most commercial growers New York has many small acreages and it is on these smaller areas that insects and disease do their worst damage.

The Long Island crop which is nearly ready for harvesting is reported to be about the biggest crop on record from the standpoint of yield per acre and also quality of the crop. Incidentally it is hard to market at a time when local potatoes and potatoes from other sections are being harvested at the same time This results often in too many potatoes going to market at the same time with the resultant low prices. Growers frequently are taking considerably less than the support price when selling to commercial dealers for cash.

An estimated attendance of more than 12,000 was reported for the Empire State Potato Club Field Day held at Bliss,—on the farm of Burt Peffer on the 8th of August. This was a tremendous interest on the part of the growers in New York State in the potato industry Carl Smith, former Commissioner of Agriculture from the State of Maine, was the chief speaker Dr. Guterman from the College of Agriculture spoke on the research being conducted at Cornell. Potato varieties, diseases and test plots planted by various departments of the College of Agriculture were living examples of work being carried on. Demonstrations of farm machinery were conducted throughout the day.

The Adirondack Potato Growers held a Field Day in Malone on the 13th of August which was also well attended. Although this was a local Field Day, visitors represented many other sections including Maine and Washington. This was the first Field Day for the recently organized Adirondack Growers and bespeaks the enthusiasm these men are putting into their new association. (Aug. 26).—H. J. EVANS.

OHIO

The Cobbler crop is about 90 per cent harvested but not more than 75 per cent marketed Some growers are now digging Katahdins. The crop in southern Ohio is the largest for many years, possibly because of ample rains and cool weather.

The weather in northern Ohio has been dry but cool The early crop is light and the late crop has been damaged by dry weather.

There was some late blight earlier in the season, but the dry weather has stopped the spread and there has been very little damage.

Black leg has been more prevalent than in many years,—due to the cool wet weather. Some fields are showing considerable ring rot

Our potato movement has been active during the past week and the Cobbler crop will probably be marketed at the end of another week. The quality of the early crop has been exceptionally fine. (Sept. 7) — EARL B. TUSSING.

OREGON

Size of Crop

It looks as though we will have about as large a commercial crop as the state ever produced. Growing conditions have been excellent—with the weather warm and frost-free in our high elevation counties, and excellent stands in our other areas.

Certified Areas

About the same as last year when we passed 4,261 acres of all grades and inspected about twice that much. Total acreage entered will be less than last year but a higher percentage will probably pass. Growers are generally roguing much earlier and a large percentage of the acreage has been dusted for aphid control. The earlier dustings were with ground outfits, but after the vines began to touch, most of the growers switched to airplane dusting. Preliminary work last year indicated that a good job of aphid control resulted in must better disease control. Anyhow this year we have markedly less current season leaf

roll than last year in our seed fields, whereas undusted commercial fields are full of current season leaf roll

Test Plots

Plans are about completed for the far western states to plant seed samples again near Oceanside, north of San Diego, California Since much of the Oregon seed is immature, dormancy must be broken by chemicals. Following the California readings,—usually made in February,—this state plants another plot at Corvallis to serve as a check and also in order that growers may see the performance of their seed The distance from Corvallis to San Diego is 1,240 miles, which makes the trip too expensive for small growers.

PENNSYLVANIA

In general the potato crop throughout Pennsylvania is good However, black leg has been a serious problem during the season It has apparently been more severe on the Sebago variety but has been present in amounts up to 10 per cent in such varieties as Katahdin, Cobbler and Russet Rural Pennsylvania-grown seed has shown this disease in trace amounts, but certified stock from other areas has varied from medium to severe

Late blight is present in all areas but a good job of spraying is holding the disease in check to date. Unsprayed plants in various fields have died as a result of this disease

Bordeaux mixture at a concentration of 8-4-100 still continues to be the standard material for controlling this disease. In most instances where dusts have been used, growers have failed to control late blight

Ring rot is now making its appearance but does not seem to be so general as has been the case for the past two or three years. (Aug. 28). —O. D. BURKE.

SOUTH DAKOTA

The potato harvest is under way in this area with good yields reported in most cases. Indications are that the average yield will be in the neighborhood of 175 bushels per acre with many fields exceeding 200 bushels per acre The quality is very good and washed number 1 potatoes are selling from $2.65 to $2.85 per hundred in Chicago

Some certified Bliss Triumphs have been shipped to Cuba and Southern Florida. Labor is plentiful at the present time and no shortage is anticipated. The quality of the certified stock is excellent, but the final acreage passing all inspections will be low. Of the 7,195 acres

entered for certification, approximately 50 per cent have been rejected for a trace of ring rot and a few fields for more than 1 per cent of virus disease. The head field inspector, David Giese, is continuing the check of fields during harvest.

The Government support of potato prices is being carried on through the purchase of field-stored potatoes at $1.35 for U. S. No. 1 and $.45 for U S. No. 2 potatoes Inspection is made by the Federal-State inspector and the program will continue until the 15th of September,—after which time prices will be supported through loans on potatoes in permanent storage. The acreage of all potatoes in South Dakota this year is placed at 28,000 acres and the yield per acre for the state at 79 bushels per acre. In the area in the Northeastern section of the state where over one-half of the acreage is concentrated the yield is expected to be double that indicated in the August crop report

Government officials who attended a meeting at Huron recently in regard to the support program on potatoes wonder how long it will be necessary for the Government to aid potato growers. It was pointed out to them that the acreage in the United States this year was the smallest since 1893 but that the yield of 163.3 bushels per acre was much above the average An average yield on this small acreage could easily cause a shortage of potatoes

In the case of potatoes, or perishable products, it might be necessary to make bushel allotments to farmers and if the yield exceeded the average production, no support would be given on that portion of the crop. (Sept 6).—JOHN NOONAN.

WASHINGTON

The harvesting of both seed and commercial potatoes is well under way in Washington We have had a much larger production than we expected and the potatoes, in general, are running high in quality.

The acreage of certified seed potatoes is a little higher than last year. However, the market at the present time is decidedly dull. Where a majority of our White Rose seed are usually contracted at this time of year, there is very little seed sold for Fall delivery The commercial potatoes swung heavy to the White Rose variety and these are being harvested rapidly at the present time.

Our commercial growers and also our seed growers are reporting excellent results in the control of insect pests by the use of DDT and in the areas where late blight is a serious factor, the addition of copper dust to the DDT is showing excellent blight control. (Sept. 3) —CHAS. D. GAINES.

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THE CALROSE POTATO: A NEW VARIETY POSSESSING RESISTANCE TO LATE BLIGHT

C. F. CLARK[1]

Riverside, Cal.

In many sections of the country in the potato producing districts the crop is subject to occasional attacks of late blight but because of their infrequent occurrence few growers take precautions to protect the plants from infection by the usual methods of spraying and dusting The prevention of losses from this source could easily and economically be achieved by the use of resistant varieties if such varieties were available to the grower.

Although varieties of high market and table quality immune to attacks by the late blight fungus (*Phytophthora infestans* (Mont.) De By.) are not yet in commercial production, segregates of good commercial types that possess sufficient resistance to protect the crop against mild attacks of this disease have been obtained in the potato breeding plots of the United States Department of Agriculture. In tests conducted in California one of these seedlings, designated in the breeding records as No. 672-26, and later named Calrose, has proved to be well adapted to certain sections in the state where late blight occurs.

ORIGIN.

The variety Calrose, which was originated by the United States

[1]Collaborator. Formerly horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, Washington, D. C.

Department of Agriculture from a cross between the varieties Ackersegen and Katahdin, was first grown in 1934 at Aroostook Farm, Presque Isle, Maine The complete pedigree of this variety follows:

- Calrose (U.S D.A. seedling No. 672-26)
  - Katahdin
    - U.S.D.A seedling No. 24542
      - Sutton's Flourball
      - Aroostook Wonder
    - U S D.A seedling No 40568
      - Busola
      - Rural New Yorker No 2
  - Ackersegen

The most important characteristics of Katahdin, the pollen parent, so far as they relate to this cross, are its resistance to mild mosaic and its smooth, good-shaped tubers. The predominant feature of Ackersegen, a late-maturing variety from Germany, is its resistance to late blight.

The first commercial distribution of this variety was under the name of Calpride, which was later changed to Calrose to avoid confusion with the use of Calpride by a grower as a trade name for his stock of White Rose

Description.

Plants. Large, spreading; stems medium in thickness, prominently angled; nodes slightly swollen, green; internodes usually green, or in spring crop slightly pigmented in upper part of stem; wings small, straight or slightly waved in lower part of stem, distinctly waved in upper internodes, green; stipules small, green, not pubescent, those of lowest peduncle small, divergent; leaves long, medium in breadth and type; midribs green, scantily pubescent; petiolules green, scantily pubescent; primary leaflets (lateral) four or five pairs, ovate-elliptical, generally symmetrical, medium in size, mean length of blade 45.24 ± 0.41[2] mm. (1 78 inches), mean width 27.83 ± 0.26 mm. (1.10 inches), index 61 57[3]± 0.29; terminal leaflets ovate, somewhat truncate at base or sometimes slightly decurrent; petiolules green, slightly pubescent; secondary leaflets medium in number, in three positions: on midrib between pairs of primary leaflets, at junction of midrib and petiolules, and on petiolules; tertiary leaflets few; inflorescence little branched; peduncles short, green, abundantly pubescent; leafy bracts usually

none, when present small, leaflike; pedicels medium in length, mostly green, sometimes slightly pigmented below cork ring.

Flowers. Much abscission of earliest buds before opening; calyx lobes medium in length, awl-shaped, green, scantily pubescent; corolla medium in size, pale lilac with white tips which are densely covered at apex with fine, white hairs; anthers lemon yellow to greenish yellow; pollen scant; style straight; stigma trilobed, green.

Tubers. Large, regular in outline, elliptical to elliptical—elongated, or cylindrical in largest sizes, basal end sometimes narowed; mean length 120.07 ± 1.01 mm. (4.73 inches)[4], mean width 66.50 ± 0.46 mm. (2.62 inches)[4], mean thickness 53.23 ± 0.48 mm. (2.09 inches)[4], indexes, width to length 55.68 ± 0.51[5], thickness to length 44.57 ± 0.49[6], thickness to width 80.17 ± 0.62[6]; skin smooth, tough, dark cream-buff (classed as white by the commercial trade); eyes shallow, same color as skin; eyebrows short, curved, inconspicuous, color of flesh near cream. Sprouts, when developed in dark, mostly white, some with trace of color in terminal leaf scales and rarely in lower part of body of sprout; when developed in diffuse light, terminal leaf scales greenish, tinged with reddish purple at tips, lateral leaf scales mostly light green, sometimes with slight tinge of reddish purple, body of sprout well pigmented (Ridgeway's[7] deep purplish vinaceous to dull Indian purple).

Maturity late.

CHARACTERISTICS.

The Calrose variety possesses many of the desirable characteristics that constitute a good market potato. The tubers are long, smooth, with shallow eyes, and very attractive in appearance. They are regular in outline, rarely developing second growth "knobs", even when grown

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[2]Standard error.

[3]Calculated by dividing the width of each of 100 leaflets by its length and multiplying the average of these ratios by 100 The leaflets were taken from the fourth leaf from the top of the stem, one leaflet, the distal left lateral, being taken from each leaf. The length of the leaflets was determined by measurement from the apex of the blade to the base of the lobes. In asymmetrical leaflets the average of the measurements to the base of each lobe was taken as the length. This, with slight modification, is the method described on pages 163 to 170 by Salaman. R. N. *Potato Varieties,* 378 pp, illus. Cambridge 1926

[4]Averages of measurements of 100 tubers 8 to 11 ounces in weight

[5]Calculated by dividing the width of each of 100 tubers by its length and multiplying the average of these ratios by 100 The data used for calculating the indexes were taken from the same measurements as those used to designate the dimensions of the tubers

[6]Based on the measurements of the same tubers as those used for determining the width-to-length index, using the same methods of calculation.

[7]Ridgway, R. Color Standards and Color Nomenclature 43 pp., illus. Washington, D. C. 1912.

under unfavorable conditions. The skin is relatively tough, which reduces to a minimum damage from bruising. When cooked the tubers of mature stock grown in California are classed as medium in dryness, with a slightly waxy consistency. The flavor is good. The period of growth of this variety is somewhat longer than that of White Rose, the variety most extensively grown in California, consequently the harvesting and marketing of the crop in a district could be extended over a longer period by the use of this variety for part of the acreage, since it seems to be more tolerant to hot weather than White Rose.

Calrose is moderately resistant to late blight. In tests at Aroostook Farm, Presque Isle, Maine, in 1937, it was placed in the third class with respect to resistance, in a scale of eight classes, the first class representing immunity. M. A. Lindsay reports[8] that in California in fields where late blight occurred with sufficient severity to kill White Rose vines Calrose continued to grow normally. Only very meagre information is available regarding its resistance to other diseases. That it is not entirely resistant to the virus diseases is shown by the report on the seed stock entered for certification in California in 1945 which lists 0.10 per cent of haywire and 0.10 and 0.40 per cent of mosaic of undesignated type in this variety. It is susceptible to *Fusarium oxysporum*

ADAPTATION.

The chief tests of this variety have been made in California where it was considered the most promising of about 450 seedling varieties of the United States Department of Agriculture tested in 1937 and 1938 through the cooperation of the California Agricultural Experiment Station. Its vigorous growth and high production ability indicate that it is well adapted to conditions in several of the potato-producing districts of the state. The set of tubers is large so that with the abundant supply of moisture furnished by irrigation good yields are obtained. Glen N. Davis of the California Agricultural Experiment Station reports that in yield tests conducted at Shafter in 1944 "there was no significant difference in yield between Calrose and White Rose when harvested at the same time (time at which White Rose was mature). Calrose normally matures somewhat later than White Rose and would probably yield higher if allowed to grow to maturity". M. A. Lindsay, Kern County Farm Advisor, states that "in Kern County the Calrose has, in general outyielded White Rose when grown side by side".

[8]Lindsay, M. A. Sectional Notes Amer. Potato Jour 22(9):289 1945.

DISSEMINATION.

The United States Department of Agriculture has no seed of this variety for general distribution There is, however, a considerable amount of seed available in commercial channels as approximately 36,000 bushels were certified in California in 1945

SUMMARY

Calrose is a high-yielding variety that has proved to be well adapted to environmental conditions in California It produces an abundant set of tubers that are long, smooth, and attractive in appearance. This variety possesses sufficient resistance to late blight to protect it against mild attacks of this disease, therefore it should prove to be a useful variety in potato-producing districts where late blight occurs. It requires a relatively long period of growth, which should enable it to supplement other varieties in extending the length of the harvesting and marketing period in districts where this would be desirable.

SPRAYING AND DUSTING POTATOES WITH DDT AND OTHER MATERIALS[1]

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AND

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Psyllid yellows, caused by the potato and tomato psyllid *Paratrioza cockerelli* Sulc, is one of the most serious potato diseases in Colorado. The damage to the crop varies from year to year depending on the psyllid population and effectiveness of control measures.

Flea beetle injury to potatoes, caused by the larvae of the tuber flea beetle *Epitrix tuberis* Gentner, is very severe in eastern Colorado. Flea beetle injury does not, as a rule, decrease the yield of tubers but

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does reduce the market value of the crop. The injury to the surface of the tubers is generally termed worm-track, and the injury caused by the larvae penetrating into the tuber is called stings or slivers.

Early blight, caused by *Alternaria solani,* as a general rule, is not a serious problem in the late crop in the Greeley district. However, in 1945, it became rather severe and thus afforded an opportunity to study its control.

Spraying and dusting experiments were conducted at the Colorado Potato Experiment Station at Greeley, Colorado, in 1945 to determine the effectiveness of DDT in controlling psyllids and flea beetles on potatoes. In addition, bordeaux mixture and Dithane were tested for the control of early blight and to determine their compatibility with DDT.

The results of this experiment are presented as a progress report because of the general interest in the use of DDT for controlling potato insects and because of the favorable results obtained with regard to control of leafhopper and lygus bugs.

Materials and Methods

The experiment consisted of eight treatments planted as an 8 x 8 Latin square. Each plot consisted of eight rows spaced 34 inches apart and 55 feet in length. At their ends the plots were spaced 15 feet apart. Seed pieces, weighing about 2 ounces each, of the Triumph variety were planted on the 15th of June. At harvest, the 27th of September, the length of the plots was reduced to 50 feet, and yield data were taken only on the two center rows of each plot.

Irrigation water was supplied throughout the growing season whenever the plants seemed to require it in order to make a continuous vigorous growth. The quantity of water applied varied with each application according to the size of the plants and the moisture in the soil. The dates of irrigation were the 20th of July and the 3rd, 15th, and 30th of August.

The eight treatments comprised in this study were as follows:

1 Liquid lime-sulfur, 2½ gallons; basic copper arsenate, 5 pounds; and 100 gallons of water.
2. Liquid lime-sulfur, 2½ gallons; and 100 gallons of water.
3. DDT, 1 pound; and 100 gallons of water.
4. DDT, 1 pound; packaged bordeaux mixture 12 pounds; and 100 gallons of water.
5. DDT, 1 pound; Dithane, 2 quarts; zinc sulfate, 1 pound; hydrated lime, ½ pound; water, 100 gallons.
6 DDT, 3 per cent; inert dust carrier, 97 per cent

7. DDT, 3 per cent; sulfur, 60 per cent; inert dust carrier 37 per cent.
8. Untreated.

The liquid lime-sulfur showed a Baumé test of 32°. The bordeaux mixture used was a ready-mixed product containing 12.5 per cent of metallic copper and was prepared at the rate of 12 pounds to 100 gallons of water, which would equal 6-x-100 strength The DDT used to prepare the sprays and the dusts was a dry, wettable powder containing 50 per cent actual DDT.

The materials were applied with a four-row power sprayer and a four-row power duster. The sprays were applied at approximately 125 gallons per acre with 450 pounds pressure, using three nozzles to the row. The duster was equipped with two nozzles per row and a 12-foot apron. The dusts were applied at the rate of 25 pounds per acre, a weighed amount being applied to each plot.

The first application was made when the plants were 4 to 6 inches high. Five applications were made on the following dates: the 19th and 26th of July and the 2d, 9th, and 27th of August. Because of an error the DDT was omitted from the fifth application of treatment 5.

The effect of treatments upon tuber flea beetle was measured in three ways: (1) Tuber injury; (2) leaf injury; and (3) adult beetle population. The tuber-injury readings were made from 100 tubers of marketable size taken at random from each plot at harvest. They were graded from 0 to 10,—according to degree injury. Leaf injury was determined by counting all food punctures on 50 leaflets picked at random from the upper one-third of the plants on the 2d, 10th, 20th, and 28th of August. Adult beetle populations were determined, from 20 strokes of a standard 14-inch insect net in each plot on the 3rd, 10th, and 24th of August. Sweeping records for adult populations were made 1 day after the third and fourth applications; 15 days, after the fourth; and 3 days, before the fifth application. Early blight infection was graded according to the amount of injury from 0 to 5 Readings were made on the 6th of September from 50 plants in each plot.

Experimental Results

The psyllid population was unusually low in the Greeley district in 1945 It will be noted in table 1 that only 16 nymphs were found on 1,600 leaflets examined, and 9 of these were on the 200 leaflets from the untreated plots. Reduction in yield is the best measure of psyllid injury on potatoes It is apparent from the data in table 1 that the yield from the untreated plots was not significantly different from

TABLE 1.—*Summary of results from spraying and dusting of potatoes at Greeley, Colorado, in 1945. Yields in tubers 1⅞ inches in diameter or more.*

Treatment	Yield per Acre	Early Blight[1]	Flea Beetles			Total Psyllid Nymphs	Average	
			Tuber Injury[2]	Leaf Injury	Adult Population		Lygus Bugs	Leaf-hoppers
	Bushels					No.	No.	No.
1 Lime-sulfur, basic copper arsenate, water 2½-5-100	99.1	3.36	0.88	561.3	35.5	1	3.4	22.5
2 Lime-sulfur 2½-100 (Check for flea beetles)	98.5	3.90	3.13	906.1	45.2	1	6.6	17.8
3 DDT, 1 pound per 100 gallons of water	102.0	3.66	.99	556.8	16.9	0	4.0	8.4
4. DDT, 1 pound; bordeaux mixture 12 pounds; 100 gallons of water	129.5	1.71	1.24	510.5	25.2	1	4.5	7.8
5 DDT, 1 pound; Dithane, 2 quarts; 100 gallons of water.[3]	121.8	2.45	1.07	563.4	15.9	0	5.4	6.6
6 DDT, 3 per cent; inert carrier, 97 per cent (dust)	100.0	3.73	3.15	737.6	22.0	3	3.6	10.2
7. DDT, 3 per cent; sulfur, 60 per cent; inert, 37 per cent (dust)	99.9	3.76	2.83	748.6	19.1	1	6.0	10.8
8. Untreated	94.6	3.96	2.94	1,217.6	56.2	9	14.6	19.6
Difference required for significance — 5 per cent point	12.2	.42	.59	148.9	8.8		4.3	4.5
Difference required for significance — 1 per cent point	16.3	.56	.78	198.9	11.7		5.7	5.9

[1]Readings 0 to 5; 0, no injury; 5, very severe injury—plants practically dead.
[2]Readings 0 to 10; 0, no injury; 10. very severe injury.
[3]DDT was omitted in the fifth application. One pound zinc sulfate and ½ pound hydrated lime in all applications

those receiving treatments of known effectiveness. Therefore, no conclusions can be made regarding the relative effectiveness of the treatments against psyllids. Late-crop yields were very low throughout the Greeley district in 1945.

Protection from tuber injury is the ultimate aim in the control of flea beetles. Highly significant and equal reductions in tuber injury were obtained with four of the treatments. These were 5 pounds of basic copper arsenate in 100 gallons of diluted lime-sulfur (2½-100); 1 pound of DDT in 100 gallons of water; 1 pound of DDT to 100 gallons of bordeaux mixture; and 1 pound of DDT in 100 gallons of diluted Dithane (½-100).

The reduction in the number of leaf punctures appears to be a reasonably reliable measure of the effectiveness of the control of flea beetles. Tuber and leaf injury readings follow the adult population counts rather closely. All the treatments held the amount of leaf injury below that caused in the untreated plots. However, the best control was obtained equally with basic copper arsenate in diluted lime-sulfur; 1 pound of DDT in 100 gallons of water; 1 pound of DDT in 100 gallons of bordeaux mixture; and 1 pound of DDT in 100 gallons of diluted Dithane.

Early blight appeared about the middle of August. In approximately 10 days the infection was heavy and, as a result, very little tuber growth occurred after that date in the plots not sprayed with bordeaux mixture or Dithane. From the data in table 1 it will be noted that the reduction in the amount of injury where bordeaux mixture or Dithane was used is highly significant. The significantly higher yields obtained where these two fungicides were applied, as compared with the other treatments, can therefore be attributed to a partial control of early blight No reduction in early blight can be attributed to DDT alone, lime-sulfur, dusting sulfur, or basic copper arsenate

Records were also made of the number of lygus bugs and leafhoppers taken in the sweepings: however, these were not separated as to species. All treatments resulted in a highly significant reduction in the lygus population. The lime-sulfur probably acted as a repellent Lime-sulfur showed no effect upon the leafhopper propulation, but all DDT treatments resulted in a highly significant reduction.

Summary

Spraying and dusting experiments were made at Greeley, Colorado, in 1945 to test the effectiveness of DDT and other materials for the control of some potato insects and early blight.

Psyllid populations were so low that no conclusions could be made

regarding the relative effectiveness of the various treatments.

Five pounds of basic copper arsenate in 100 gallons of 2½-100 lime-sulfur solution, 1 pound of DDT in 100 gallons of water, 1 pound of DDT in 100 gallons of 6-x-100 bordeaux mixture, and 1 pound of DDT in 100 gallons of ½-100 Dithane solution all gave highly significant and equal control of the tuber flea beetle with regard to tuber injury.

DDT appears to be compatible with both bordeaux mixture and Dithane.

All the treatments were effective in reducing leaf injury caused by flea beetles, but the best control was obtained equally with basic copper arsenate in lime-sulfur, 1 pound of DDT in 100 gallons of water, 1 pound of DDT in 100 gallons of 6-x-100 bordeaux mixture, and 1 pound of DDT in 100 gallons of ½-100 Dithane.

Three per cent DDT dusts, when applied at the rate of 25 pounds per acre, failed to control the tuber flea beetles.

Both bordeaux mixture and Dithane reduced injury caused by early blight and gave increased yields as compared with the untreated plots.

All treatments produced a highly significant reduction in the lygus population.

All the DDT treatments significantly reduced the population of leafhoppers.

INCREASED YIELD AND DISEASE RESISTANCE OF GIANT HILL POTATOES

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Netted Gem potatoes in the San Juan district in San Benito County of California during the past few years have exhibited a decline disease or early maturity of undemonstrated cause, but associated with infection by *Verticillium alboatrum* Reinke and Berthold and *Corticium vagum* Berk. and Curt. A few large plants escape the decline each year, and progenies from such giant hill or bolter plants have manifested their resistance to Verticillium, Rhizoctonia (Corticium) and early maturity and have produced crops of higher gross yield but lower

[1]The writer acknowledges the eager cooperation of Arthur Nyland, on whose properties these tests were conducted, for the seeding and all field care of these plantings, and of R. D McCallum, Farm Advisor of San Benito County, for his assistance in making this study possible.

quality than normal potatoes for four years. Details of this situation and a review of the pertinent literature will be presented. All observations by the writer refer to the San Juan district otherwise specified

The Early Maturity Problem

Certified seed of Netted Gem potatoes are planted from about the 20th of April to the 1st of July under conditions of irrigation, but those intensively observed in this study were planted from the 3rd of June to the 1st of July each year In the absence of damaging amounts of late blight and early blight infection, the vines make a vigorous uniform growth until 60 to 75 days from planting and then slowly decline to complete death in 90 to 100 days Leaves gradually turn paler green, and die from the margin inwards. Unfortunately, symptoms have not been followed by frequent observations of the same individual plants, but the plantings were usually seen only every two weeks during the growing season. To the writer these symptoms of decline do not specifically differ from early maturity of non-diseased vines, except for the time of occurrence. but no healthy vines were observed for comparison Different parts of the same field and different fields planted with the same seed at the same and different times, varied considerably in response to decline, but none escaped, unless late blight killed the vines first. After the onset of symptoms of decline, many vines showed vascular discoloration of the stems which was especially marked near the seed piece, and this vascular discoloration became more pronounced as the season advanced. No tuber symptoms were observed.

Occurrence and Selection of Late-Maturing Plants

For the first 60 days after planting, most plants in commercial fields appear similar. With the onset of decline after 70 days, slight but apparently significant differences between adjacent individual plants begin to appear, and from 90 to 100 days there are all gradations from dead plants to a few vigorous green plants. At this time the segregation of plants into normal and late-maturing or early and late-maturing plants would be difficult and arbitrary. For example, two different observers examined the same 200 plants on the 31st of August 1945, 100 days after planting, and counted what they believed to be 2 and 15 late-maturing plants respectively On the 28th of September, 1945, 107 days from planting in another field, the individual vigor of each of 98 plants was rated on a scale of 0 to 10, in which 0 = dead and 10 = vigorous and unblemished. The results were: 0 rating—

65 plants; 1 rating—13 plants; 2 rating—9 plants; 3 rating—7 plants; 4 rating—2 plants; 8 rating—1 plant; and 9 rating—1 plant. On the 12th day of October in the presence of considerable early blight these same plants were rated as follows: 0 rating—95 plants; 2 rating—3 plants; and 5 rating—1 plant. This plant with the 5 rating was considered late-maturing though plants with a 9 rating on the same scale were also present nearby in the same field. In two other counts in 1943 and 1944, 9 late-maturing plants were identified in a total of 400 plants, and 8 in a total of 656. Even though extremes are very distinct, there is no sharp distinction by which all plants in a population may be classified as either early or late-maturing.

The first selections of late-maturing, decline-resistant, giant hill plants, which form the basis of this study, were staked on the 29th of September, 1942—106 days from the planting date They were dug on the 23rd of October, and by this time 8 of the original 16 selections had died. Sixteen adjacent normal hills were harvested for comparison. In 1943 seed from these hills were planted in one long row alternating the progeny from a giant hill and from a normal hill. All these giant hill plants reproduced the late-maturing character for which they were selected,—though to varying degrees. They were therefore truly resistant and none of them was escapes All except one or the original 16 check plants reproduced their early-maturing character, and this one exception was apparently a late-maturing plant which was not selected as such and which had apparently died before final digging. In 1944 and 1945 also progenies from normal and giant hill plants have reproduced their original characteristics but some of the least promising of the giant hill selections have been discarded Normal and giant hills have been planted, irrigated, cared for, and harvested under comparable conditions each season.

Late Maturing Plants Are Giant Hill

Although the plants which die early are considered diseased for purposes of this report, they are nevertheless normal in that they comprise about 99 per cent of the crop in any year. The conditions—normal, early-maturing, and diseased—are therefore considered to be the same in this study. The large plants which have been selected as resistant to the undesirable condition of early maturity or decline correspond well, except with respect to yield, to what has been described and commonly understood as giant hill disease (3,4,8,11,12,13,15,18,22, 23,25,30,31,32,34,35,38,39). The conditions selected, disease-resistant, late-maturing, and giant hill are therefore considered to be the same

for the purpose of the present discussion. This anomalous situation where the diseased plants are normal, and the disease-resistant plants are all diseased, and there are no healthy plants, is one of several confusing features of this study.

Characteristics of Giant Hill

The characteristics of giant hill as seen in this study are summarized in table 1. Unless otherwise indicated, the data are the average or range of all samples over the 4-year period of these tests. Different selections showed important differences among themselves as will be indicated later For the sake of brevity some of the comparisons of normal and giant hill plants given in table 1 will not be treated further, but some of the more important characteristics warrant further discussion.

The average of all records of the seasonal growth of vine for normal and giant hill plants in 1945 is given in figure 1. Plants from normal

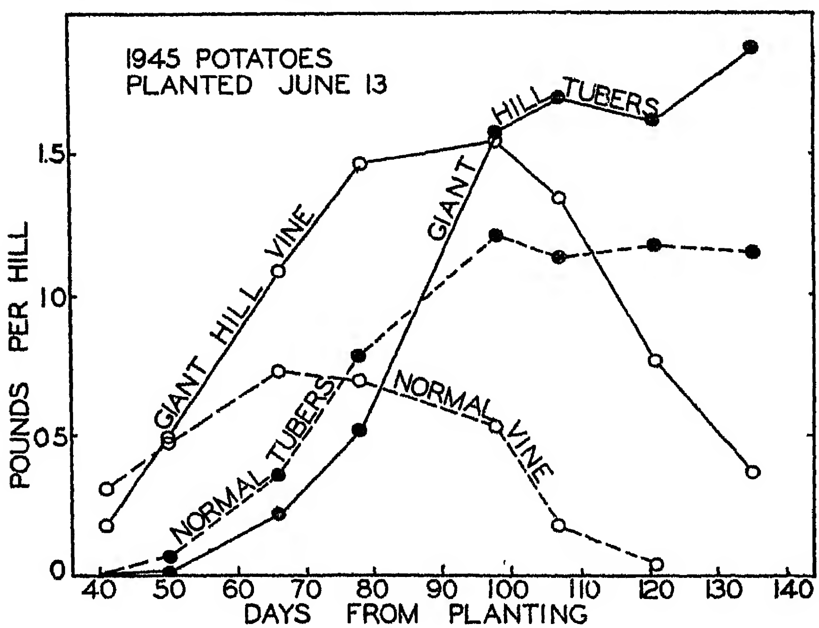


FIGURE 1 Comparison of seasonal growth of normal and Giant Hill potatoes at San Juan, as measured by average green weight of tops and weights of tubers.

seed came through the ground first, and were initially heavier than those from giant hill seed, but at 50 days from planting the green weight of normal and giant hill vines was about equal. At 65 days from

TABLE 1.—*Comparison of normal and Giant Hill potatoes at San Juan from 1942 to 1945.*

Character	Normal	Giant Hill
Vine		
Length at maximum growth, inches	12 to 19	19 to 40
Weight at maximum growth, pounds per hill	0.3 to 1.1	0.7 to 5.0
Stolons	Normal	Increased number and length
Branching	Normal	Increased
Cracking of stem surface in soil	None	Extensive, longitudinal
Number of stems per set	1.98	1.48
Growth type	Determinate	Indeterminate
Flowering	Normal	Increased
Leaf		
Size	Normal	Smaller than normal
Form	Normal	Edges may turn up
Growth period, estimated range in days	70 to 100	90 to 140
Tubers		
Dormancy	Normal	Longer dormant period
Shape	Normal	Deeper eyes, pointed more overgrowths
Grade, one 1945 record	72 per cent U.S. No 1	56 per cent U.S. No. 1
Weight per tuber, pounds	0.31	0.41
Specific gravity	1.064 to 1.095	1.046 to 1.110
Yield per hill, range of all records, pounds	0.3 to 3.0	0.8 to 5.7
Cooking quality	Normal	Poorer at 107 days, equal at 135
Diseases		
Pythium tuber rot	Susceptible	Susceptible
Seed piece decay	Normal	Slower
Late blight — vine	Susceptible	Less susceptible
Late blight — tubers	Susceptible	Susceptible
Early blight	Susceptible	Less Susceptible
Rhizoctonia — stems	Susceptible	Less Susceptible
Rhizoctonia — sclerotia on tubers	Normal	Fewer
Verticillium infection of stems	Susceptible	Resistant
Miscellaneous		
Drought	No observations	May resist drought
Frost	Susceptible	Resistant
Weed growth between rows	Extensive	Slight

planting the normal vines had reached their maximum weight of 0.72 pounds per hill, but the giant hill plants did not reach their maximum of 1.53 pounds until 98 days after the planting date. The decline from maximum green weight of vines to death was slow, but was relatively more rapid for giant hill than for normal, possibly because in the 1945 season as in others, early and late blight became more widespread and destructive as the season advanced.

Tubers from giant hill plants are larger, have deeper eyes, are more pointed or spindle-shaped, and have more overgrowths than normal tubers By consideration of the characters—depth of eyes, shape, and amount of overgrowths—it was attempted to estimate the quality of the tubers of many lots of tubers on a scale of 0 to 10 in which 0 indicated entirely unfit for culinary sale, and 10 indicated excellent form of all tubers. On this basis the rating of the 16 normal hills in 1942 ranged from 7 to 10 and averaged 8.6 whereas the 16 giant hill selections ranged from 5 to 9 and averaged 6 6. Progenies of these original normal plants in 1943 ranged from 7.8 to 9 0 and averaged 8.1 whereas the giant hill ranged from 5.9 to 9.1 and averaged 7.6. In 1945 small samples of the harvest were graded into U. S. No. 1 potatoes and those not U. S. No. 1 by one experienced in potato grading. Two lots totaling 80 pounds of normal tubers averaged 72 per cent No. 1, whereas four lots totaling 197 pounds of giant hill potatoes averaged 56 per cent No. 1. Typical specimens of normal and giant hill tubers are illustrated in figure 2.

The cooking quality of normal and giant hill tubers was compared. Samples dug on the 28th of September, 1945,—107 days after planting were submitted to the Department of Home Economics, and Dr. Barbara Kennedy reported as follows:

Baking. both acceptable and no difference noted.

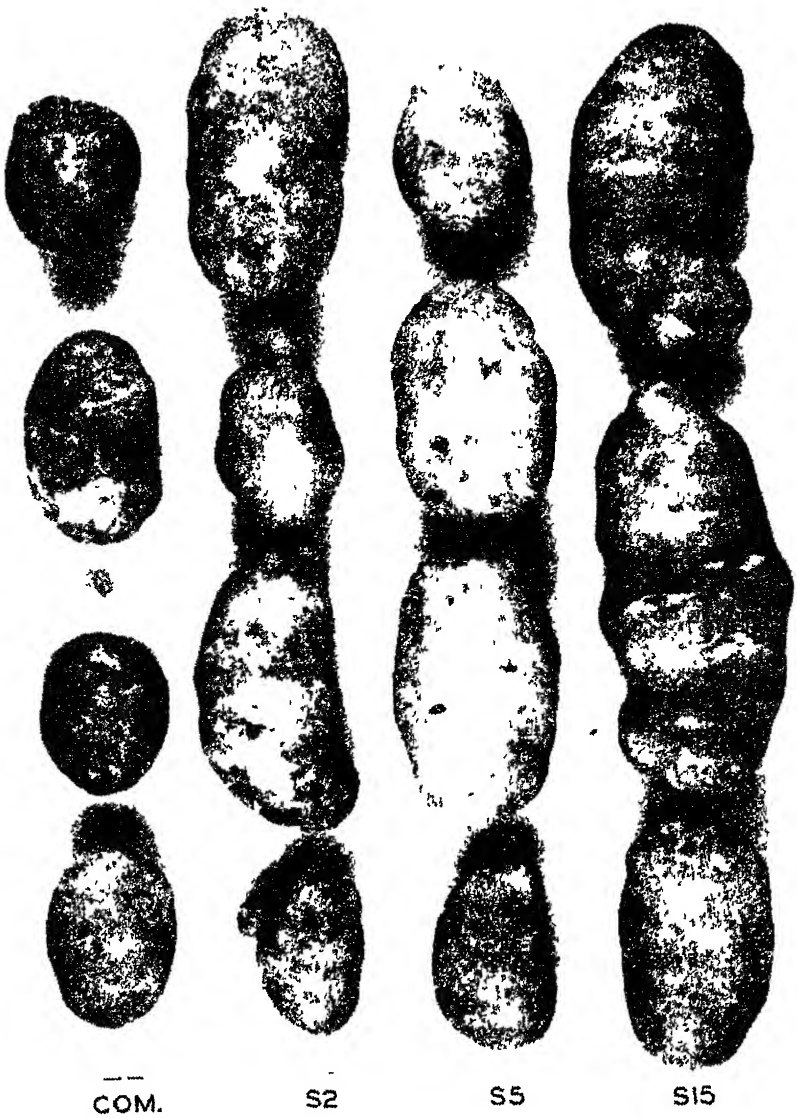
Boiling: both acceptable.

Normal: white mealy with a little sloughing Flavor O. K.

Giant Hill: slightly greenish tint; mealy; with no sloughing. Flavor O K.

Samples submitted the 26th of October when the giant hill tubers were mature showed no difference in baking, boiling. or eating quality between normal and giant hill. In the writer's home no difference in eating quality was detected by four adults between normal and giant hill baked tubers. One other non-professional observer in another household considered the giant hill of slightly poorer eating quality.

The specific gravity of tubers was measured by weighing individual tubers in air and in water and making appropriate calculations. Each value given represents a minimum of 3, and an average, of 5 determinations On the 1st of September, 1944, 77 days from planting, tubers from normal hills averaged sp. gr. 1.083; and from giant hills, 1.065. On the 15th of September, the corresponding values were 1.084 and 1.063, and on the 29th, 1.086 and 1 088. Tubers harvested on the 9th of September, 1944, 106 days after planting at Half Moon Bay, California, gave the following values· Normal Netted Gem 1.095, giant hill 1.092;



JRE 2. Compaiison of tuber type of normal (left vertical iow) and 3 of giant hill (right) Note the greater size, later matuiity, spindle shape, yes, greater tendency for secondary growths, and fewer ihizoctonia sclerohe giant hill tubers (than on noimal tubers) S5 is one of the more strains; S2 is the least desirable

normal White Rose 1 091, giant hill 1.079. The 1945 values for Netted Gem at San Juan were: August 17,—65 days from planting, normal—1.070, giant hill 1.060; August 31, normal 1.081, giant hill 1.068; October 12, normal 1.078, giant hill 1.077, and October 26, normal 1.078, giant hill 1 093. The specific gravity of the giant hill tubers is, therefore, lower than that of the normal at the time the normal mature, but may be greater than the normal by the time the giant hills mature.

Increased Yield of Giant Hill Plants.

In the San Juan district giant hills yield less than normal in the early part of the season but yield more if the giant hills are grown to maturity. Average data for 1945 are presented in figure 1 and data at final harvest at all locations and all seasons are given in table 2. Differences in rate of early tuber formation are one of the most striking differences between giant hills and normal plants. On the 24th of July, 1945, 41 days from planting, the average number of tuber initials (stolons with swollen tips) per hill for the normal was 8.1 weighing a total 2.4 grams, whereas for the giant hill was 0.25 weighing 0 1 gram. On the 2d of August, the corresponding values for the same planting were 7.2 tubers and 51 grams for the normal and 2 5 tubers and 6.6 grams for the giant hill. At later harvest dates the difference between normal and giant hill became progressively less until the yield of giant hill reached that of the normal approximately 86 days after planting (see figure 1) and from then on, the yield of giant hill became progressively greater than normal until at final harvest the average yield per hill was 3.8 tubers and 1 14 pounds for the normal, and 4.5 tubers and 1.88 pounds for the giant hill In 1944 the average yield ranged from 0.59 pounds per hill at 63 days from planting (first record) to 1.75 at 129 days for the normal and 0.38 to 2 84 pounds for the giant hill at the same harvest periods, respectively Maximum yield was attained in about 100 days for the normal, but, since some of the vines were still green and the yield curve was still rising for the giant hill at the time of harvest, the maximum yield was never attained for the giant hill. However, on the basis of yield records over a period of 4 years (see table 2) the writer believes that about 60 per cent greater gross yield can be attained from the giant hill than from normal potatoes in the San Juan district. Although the absolute field is much greater for the giant hill than for the normal, the yield of tubers per unit weight of vine is less for the giant hill. From the data in figure 1 a final yield of 1.14 pounds was produced by a maximum weight of vine of 0.72 pounds, or tubers were formed at the rate of 1.59 pounds of tubers per pound of vine for the normal whereas similar calculations give 1.22 pounds of tubers per pound of vine for

TABLE 2—*Yield from normal and giant hill potatoes in different districts*

Variety	Location	Date of Planting	Growth Period	Hills Harvested		Average Weight of Tubers per Hill.	
				Normal	Giant Hill	Normal	Giant Hill
			Days	No.	No.	Lbs.	Lbs.
Netted Gem	San Juan	June 15, 1942	130	16	16	1.07	1.73
Netted Gem	San Juan	June 3, 1943	123	183	224	1.35	1.83
Netted Gem	Half Moon Bay	May 25 1944	106	23	20	1.95	2.52
White Rose	Half Moon Bay	May 26, 1944	106	7	8	2.60	3.35
Netted Gem	San Juan	June 21, 1944	130	27	34	1.61	2.84
Netted Gem	Stockton[1]	April 1, 1945	147	100+	100+	2.19	1.59
Netted Gem	Berkeley	April 12, 1945	120	11	13	0.73	0.61
Netted Gem	San Juan	June 13, 1945	136	105	1339	1.14	1.85

[1]Calculated from data furnished by H G. Zuckerman.
The writer did not see this planting.

the giant hill. If time is also considered in such calculations the relative efficiency of the normal and giant hill vines appears about the same as by the method just used. About 43 total pound days of vine (days of growth x pounds of vine, or the area under the vine curve) or 38 pound days of vine per pound of tubers were required for the normal as contrasted to 50-pound days of vine per pound of tubers for the giant hill. These data might indicate that giant hill vines were photosynthetically less efficient than normal vines.

In addition to the observations at San Juan, comparative yield records were secured from plantings at Half Moon Bay, Stockton, and Berkeley (see table 2) The records for Half Moon Bay indicate a 29 per cent increased yield for giant hill, but the records for Berkeley and Stockton show an average decrease in yield of 21 per cent for giant hill. Other records of yield effects from giant hill are as follows. Folsom, Schultz, and Bonde, 1926 (12)—4 per cent increase at 132 days; Folsom, 1927 (11)—slight reduction to slight increase; Folsom, Owen and Smith, 1931 (13)—20 per cent reduction; Hansen, 1936, (17)—33 per cent reduction; Hill, 1934 (18)—49 per cent reduction; McIntosh, 1931 (27)—reduction in yield of marketable tubers; McIntosh, 1940 (28)—considerable reduction in early varieties lifted early; McIntosh, 1945 (29)—July 17 - 23 per cent reduction, October 4—1 per cent reduction; McCubbin *et al* 1926 (25)—decided reduction in yield; McKay *et al* 1933 (30)—may be increase in gross yield; Pullen and Wasserman, 1935 (34)—increase in yield may result; Chester, 1942 (7)—few or no usable tubers, and Raeder 1944 (35)—yield slightly increased. The general picture of the effect of giant hill on yield is therefore very confusing but the predominant opinion is that giant hill reduces yield. No records of yield increase comparable to those at San Juan are to be found in other reports of giant hill.

A comparison of normal *vs.* giant hill plants with respect to resistance to fungus diseases follows.

Pythium Tuber Rot

The 1943 test plot was dug by hand with a fork and many tubers were injured About one-half of the injured tubers in the normal and giant hill lots decayed with typical leak from which a Pythium was isolated. Artificial inoculations with pure cultures demonstrated that this organism was highly and about equally pathogenic on normal and giant hill tubers. On the 21st of June, 1944, untreated but apparently healthy seed pieces from normal and giant hill plants of the 1943 crop were planted with a picker planter. On the 12th of July, the stand on normal and giant hill plantings was determined as 52 per cent as a

result of seed piece decay,—presumably from soil infection. Isolations and inoculations indicated that this seed piece decay was also caused by Pythium. The writer believes, on the basis of this evidence, that injured normal and giant hill tubers were about equally susceptible to Pythium tuber rot.

Normal Seed Piece Decay

In 1945, treated seed was used and there was an excellent stand and no Pythium rot of seed pieces was observed, but the condition of the mother seed pieces was recorded at most of the periodic harvests throughout the season. The per cent of sound seed pieces was as follows: July 24 (41 days from planting) normal 100, giant hill 100; August 2, normal 57, giant hill 80, August 17, normal 31, giant hill 64; August 31, normal 13, giant hill 58; September 19, normal 0, giant hill 37; and September 28, normal 0, giant hill 13 The cause of this seed piece decay was not determined and there is no basis for considering it as injurious to the crop, but a slower rate of decay for giant hill than for normal seed pieces is conclusively indicated.

Late Blight.

(*Phytophthora infestans* (Mont.) de Bary killed several areas of vines each year, but was always more spotted in its distribution in the fields than was the early maturity under study. The first notice of late blight was as follows: 1941—September 26, already abundant, 1942—September 12, already abundant; 1943—August 26, trace; 1944—September 1, trace, and 1945—August 17, slight. The possibility that late blight was responsible for the early death of the vines throughout the district was considered, but no satisfactory correlation between late blight and early maturity could be established, and applications of Bordeaux spray in 1941 and 1942 not only failed to arrest the early death of the vines in the presence of late blight but actually hastened the death. Symptoms of late blight were of course distinct from the early maturity described here. Late blight was much more severe on White Rose than on Netted Gem and on Netted Gem than on Sebago, though infection on Sebago was much heavier than would be expected in a so-called resistant variety.

Any attempt to describe the comparative field behavior of normal and giant hill vines is difficult because late blight did not usually become abundant until decline had set in and late blight has appeared superficially to behave differently in different seasons and locations In one case an early severe attack of late blight in a commercial field appeared to have killed the giant hill vines, for there were no giant hills

present in the severe blight area, whereas about 1 per cent of the vines outside this area were giant hills. On the other hand, in one commercial field and in the 1944 test plot, where most of the plants were dead and where late blight was observed to have been abundant earlier, no late blight lesions could be found on most of the giant hill plants still standing on the 27th of October. When late blight has appeared in slight amounts at the onset of decline as in the test plot on the 17th of August, 1945, the size and frequency of the lesions appeared equal on normal and giant hill plants in adjacent rows. As late blight increased in successive observations, the normal vines slowly died but the giant hills continued to grow in length and in weight In two greenhouse inoculation tests involving a total of 10 normal and 9 giant hill plants, the average blight severity rating (0=none to 10=very severe) was 5.3 for the normal and 4 2 for the giant hill. On the basis of this inadequate evidence the writer believes that giant hill vines are slightly more resistant to late blight than are normal vines.

Despite abundant vine infection in this district, with its practically rain-free growing season, no late blight infection was found on the tubers Artificial inoculations indicated that normal and giant hill tubers were equally and highly susceptible, though these tests would not have revealed small differences.

Early Blight

Alternaria solani (Ell. and Mart) Jones and Grout has been present each year from 1941 to 1945, always less violent in its attack and usually later in its occurrence than late blight. No adequate observations of its time of occurrence, importance, or relative severity on normal and giant hill potatoes were made, though this would have been complicated by the early onset of decline, the same as in late blight. However, on the 19th of September, 1945, there were about 3 early blight lesions per leaflet on the normal vines and none could be found on the adjacent giant hill plants On the 28th of September, early blight was abundant on both. The writer believes that the giant hills are slightly resistant to early blight, but that early blight is not an important factor in the early decline of the normal vines. It has been found more abundant on the giant hill vines after the normal had died, than it had been on the normal vines.

Rhizoctonia

The soil in the San Juan region, where potatoes and sugar beets are among the important crops, is apparently heavily infested with Rhizoctonia. Volunteer potatoes in April 1943 and April 1944 showed

Virus Diseases.

Recognized virus diseases were practically absent in this study. However, plants of one hill-unit strain of normal potatoes planted in 3 locations in the 1944 planting all showed mosaic and were discarded. No other virus diseases were noticed in the test plantings and adjacent commercial plantings grown from certified seed showed only a small amount of mild mosaic which was estimated to be about 1 per cent.

Nature of Giant Hill.

Giant hill, also called bolter (26,27,28,33,36,38)[1] or males (10) in Europe, and big tops and stags by local growers, is commonly considered to be a virus disease (7,8,9,11,15,16,17,18,21,22,24,25,32,34,35). Other observers indicate it may be a mutation (2,6,10,28,38) and others are non-committal. The genetic nature of the condition, which the writer supports, is indicated by the failures to transmit it as a virus disease, (21,26,27,28,30) though positive results have been reported (9,30), by its production from stem cuttings of normal potatoes (28), by its association with chromosome changes (37)[2] though these were not confirmed (6), and by its inheritance in crosses. This work by Carson and Howard (6) is certainly the most significant work on the nature of giant hill. They found that crosses of giant hill with normal plants yielded a high percentage of F^1 plants with giant hill characteristics. Strangely enough they also secured giant hill types from crosses of normal potatoes

Strains of Giant Hill.

The existence of strains of giant hill has been indicated by differences with respect to resistance to early blight (39), degree of wildness (6), and vine characters (28,29). McIntosh (28,29) indicates that bolters may be classified as bolters and semi-bolters. Carson and Howard (6) classify their bolter types into 3 classes on the basis of the underground parts and indicate that bolter may be an abnormal response to photo-periodicity. In the 16 giant hill families studied by the writer, there have been consistent differences between the families with respect to length of vine, susceptibility to early blight, susceptibility to Rhizoctonia, time of maturity, vascular discoloration, shape of tubers, decay of seed pieces, number of stems per vine, weight per

[1]In a letter of June 20, 1945, T. P. McIntosh writes that bolters and giant hill are identical. Identity of these two conditions is also indicated by Murphy and McKay (33) and Weiss (38).

[2]In the above-mentioned letter McIntosh indicates that the bolter nucleus always has an extra piece of chromosome included.

vine, length of stolons, degree of dormancy of tubers and yield of tubers For example, in 1945 the most productive strain of giant hill yielded three times as much as the least productive. No such large differences were observed between strains of normal type potatoes which were studied simultaneously. Although the writer's studies were, because of time of selection, principally with a group of moderate to extreme giant hill types, observations indicate there may be numerous gradations between the normal and extreme giant hill types. Carson and Howard's recovery of bolters from crosses of normal plants indicate that the genetic characters for bolters are present in normal potatoes.

Discussion

The selection of giant hill potato plants as a means of increasing yield is not new. In 1917 Gilbert (14) wrote, "Some time during the growing season the farmer should go through his commercial field and stake any plants which show qualities of unusual vigor, disease resistance, desirable habit and so on". Growers with this in mind have undoubtedly selected giant hill potatoes for seed purposes, only to discard them later because of low yield or undesirable shape of tubers. Reports of J. E. Kraus in Idaho (19) indicate that giant hill is being investigated there as a means of controlling early maturity due to Fusarium wilt (5). Apart from the association with Fusarium the situation in Idaho would appear similar to that in California.

In previous records of the comparative yield of normal and giant hill plants there is no indication that Verticillium or Rhizoctonia contributed markedly to the early decline of the normal plants, whereas in the San Juan district they were the most prominent features of the disease complex. The resistance of the giant hill plants to these fungi may be partly responsible for their increased yield

In most previous records of the yield of giant hill plants no information is given of the length of the growing period. In two records where a long growing period is emphasized (12,29) giant hill plants either outyielded the normal (12) or yielded about the same (29). In this study the normal vines outyielded the giant hill vines up to the time of decline of the normal vines, (figure 1) and it was only in the subsequent records that the high yield of the giant hill was apparent. The writer believes that heavy Verticillium and Rhizoctonia infection and a longer growing season are predominant features which differentiate this from other studies of potato giant hill. Another possibly important feature is the accidental selection of giant hill strains with high yielding capacity. In 1943, in an attempt to increase the number

of giant hill strains and to secure better ones, about 10 giant hills were harvested in a commercial field, but none appeared superior to the normal vines For a thorough study of the giant hill problem and the commercial value of giant hill strains, more numerous selections should be made.

The undesirable tuber characters of the giant hill plants are an important obstacle that may perhaps be overcome by manipulation of environment or by selection. Kraus (20) has shown that tuber overgrowths are greatly influenced by several non-genetic factors.

Summary

In the San Juan district of San Benito county, California, nearly all plantings of potatoes show a dying of the vines in 70 to 100 days from planting, associated with heavy infection of Verticillium and Rhizoctonia Longer lived selections proved to be giant hill. These have lived up to 136 days, have been relatively free of Verticillium, and have yielded an average of 63 per cent greater gross weight of tubers at 123 to 136 days from planting than normal plants Tubers from giant hill plants have the disadvantage of more overgrowths, larger size, are more spindle shaped, and have deeper eyes. Other characteristics by which giant hill plants differ from normal are: longer, heavier, and more branched vines, fewer stems per hill, increased number and length of stolons, more cracking of stem surface in soil, indeterminate type of stem growth, smaller leaves with a tendency to curl up, longer dormant period of tubers, less yield of tubers up to 90 days from planting, slower rate of seed piece decay, less susceptibility of stems and tubers to Rhizoctonia, less susceptibility of foliage to early and late blight, and perhaps greater drought and frost resistance. Strains of giant hill appear to differ greatly with respect to most if not all characteristics observed

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SECTIONAL NOTES

CONNECTICUT

Most of the well-sprayed fields came through the unusually wet. cool August in good condition; many of the others did not. At present the potatoes are being dug and are being stored as rapidly as possible. A large crop is indicated.

In some cooperative fertilizer tests on farms, it was evident that the vines remained green for a longer period where more than 100 pounds of nitrogen were added to the acre. This was true of both organic and inorganic sources of nitrogen. How yields will be affected is yet to be determined; and also if the apparent need for extra nitrogen was due to the excessive rainfall of August. (Oct. 2).—B A. Brown.

IDAHO

Harvesting of Russets started on a fairly large scale in eastern Idaho early in September and was going strong before the middle of September. All of these were for shipment and the harvest for storage won't really get under way until after the 1st of October.

Harvesting is slowed up a great deal now (Sept 25), judging from the condition of the market and probably the usual amount of potatoes will go into storage,—about 75 per cent of the main crop.

Our yields so far have been lower than anticipated,—many growers reporting a light set and rough tubers. This early harvest may not, however, be too indicative of the final yield, as the later planted fields appear to be better.

Production is estimated at 42 million bushels this year, which is about two million bushels below last year and this fact should be helpful in maintaining prices at or near the support level.

The seed potatoes in the irrigated farms are larger than last year and an even larger proportion will probably go into commercial channels this season than was the case last year, so that the actual supply of seed potatoes will be less than in 1945. (Sept. 25).—John R. Robertson

INDIANA

The potato report for our midwest section shows a decrease in production compared with last year. The 10 states (5 surplus and 5 deficient) are not so bad off as reported. Many of our growers in Indiana are taking a roller, leveling the soil, and piling the potatoes in the field. Potatoes are not moving in great quantities. We have a

number of growers who will average 500 or more bushels No. 1's per acre and some well above the 600-bushel mark. These are mostly Chippewas and Katahdins, although a few Red Warbas and Sebagoes are being harvested now. The main crop harvest is just starting and the good weather prevailing through this area may bring forth even much larger yields from our smaller acreage. It is time for the potato growers to adjust their acreages and not depend on the Government to "bail them out." The potato industry is a big business and no doubt will work out an acceptable plan before the 1947 season. (Sept. 24).—W. B. WARD.

MICHIGAN

The frost on September 3rd reduced Michigan's crop considerably. Various degrees of damage were reported in the southern part of the Lower Peninsula with very little damage in the upper part of the Lower Peninsula. Practically every field in the Upper Peninsula has been killed.

Yields will be cut below that of last year in the frosted acreas, but crops that are still green will outyield the crop of last year. Even though hard frosts have almost completely covered the Upper Peninsula, the yields there will be above those of last year.

The certified seed crop looks well,—with very good quality. The size range is medium.

Harvesting has just nicely started and will be in full swing next week. Growers who have green fields are taking advantage of another week of good growing weather.

Blight has been found in some areas, but the damage is not of any importance, however. (Sept. 22).—H. A. REILEY.

NEBRASKA

Potato harvesting operations, which are normally in full gear by this time in Nebraska, have been delayed for several reasons. In the first place, only light frosts prevailed in the southern part of the territory, where digging has been in progress for a week. Most of the area, however, was barely touched, and potatoes are so green, skinning and cracking, that the growers are reluctant to get under way. In the last two days, considerably drizzly, misty weather has "shut down" all operations, and will probably retard harvesting operations for two or three days,—until the ground dries.

The quality of the crop that has been harvested (mostly Triumph) is very good,—an occasional grower reporting scab,—but in most cases,

type, color, and the factors that strike the eye, are excellent. Because of the unusually long growing season, we are probably going to be faced by oversize in much of the irrigated potatoes, for we usually have frost by the 25th of September. This is not usually the case with dry land stock, but may be in some places.

There is much talk of government control in another year, probably on the allotment acreage basis. At least the growers are thinking along that line, and if it is proposed by government leaders, they will undoubtedly be prepared for it. Right now there seems to be some reluctance for the growers to swing in on the loan program, but with very poor prices being secured for potatoes out of the field on table stock, the loan will probably be the answer to their dilemma at present.

The prices being paid out of the field vary from 50 cents to $1 00 per cwt.,—averaging from 75 cents to 80 cents in most cases. As soon as the harvest season is over, dealers expect to shut down materially,—as these are sacrificed potatoes,—and prices, in most every one's view. (Oct. 5) —MARX KOEHNKE.

NEW JERSEY

Practically all of New Jersey's potato crop is now harvested with the exception of the late-planted seed and table stock acreage. Most of the potatoes that were piled in the fields have now been moved,—the large majority being shipped to distillers of alcohol. Most of the potatoes that were stored in these piles have kept very well,—showing a minimum of rot at the present time. Late blight is rather general in many of these fields and growers who have not kept their vines well protected with a fungicide are likely to have considerable rot in the tubers. Aphids have been severe in many areas and it is feared that they may cause an increase in the amount of leaf roll in our seed crop. Although it was quite dry during part of the growing season, indications point to a fair yield in most of the late crop fields

New Jersey growers are very much concerned about the government's acreage allotments for next year. So many false reports have come from Washington regarding the reduction that will be requested that growers are at a loss to determine how much seed to purchase or what to do with the acreage not planted to potatoes It is hoped that a reasonable reduction in acreage will be announced soon and that we will not be penalized by being classed in the early-producing areas. (Oct. 16) —JOHN C. CAMPBELL.

NEW YORK

Our crop is large,—the demand slow and the price declining. Although we have some temporary storage,—outside of Long Island and Steuben County potatoes are either going into permanent storage or into market channels. There seems to be no stabilized market, especially with outside potatoes being shipped into New York, a surplus area,—on a consignment basis.

Growers realize that both acreage and the crop must be curtailed if the support program continues. At a recent meeting, our New York growers indicated that their growers are satisfied with the state allotment for 1947. It is our general feeling that this year will see inefficient producers deciding to withdraw from the potato game.

Our yields, as well as our quality, is better than average. Many growers had to kill vines before starting their harvesting operations, especially seed growers who are attempting to prevent excessively large tubers No figures are available on the seed growers as yet, but our field readings would indicate a fair crop of relatively clean certified seed. (Sept. 30).—H. J. EVANS.

The early crop of potatoes has been harvested and largely marketed. Growers are now rushing the harvesting of the late crop in hopes of finishing before fall rain and cold weather come.

The first killing frost in central and southern Ohio came on the 1st of October; but it did not extend to the northern section.

Unusual yields are being reported. One grower reported a checked acre of Katahdins at 969½ bushels. The quality has also been exceptionally high.

Maine is now shipping some cars into Ohio as well as other eastern states and Wisconsin. Idahoes are arriving on the markets.

The growers have been so busy harvesting that little thought has been given to the control program. In fact, growers have not been invited to participate in any meeting up to this time. Ohio is a deficient area; therefore, no government purchases have been necessary However, growers realize that purchases in shipping areas have added greatly in maintaining higher prices. (Oct 3).—E B TUSSING

SOUTH DAKOTA

Potato digging in South Dakota is rapidly drawing to a close. The weather has been ideal,—with very little time lost because of rain.

About 190,000 bushels of potatoes were purchased by the government in field storage. We don't expect any temporary storage. P. M. A. officials are now making inspection for permanent storage loans. The field storage program represents about 10 per cent of our production in the potato area, so that is not very important, except for the grower who did not have storage. Our crop is very good, with many yields exceeding 200 bushels per acre. The washed table stock from this area is topping the market in Chicago.

Our acreage in South Dakota is only 28,000 this year; 4,000 less than last year. It's not the acreage; it's the yield that makes the surplus. If our acreage were reduced, we could have a potato famine under unfavorable weather conditions. I believe the program should be based on production,—rather than acreage. (Oct. 2).—JOHN NOONAN.

VERMONT

Offsetting an all-time low acreage (10,600), Vermont's 1946 potato crop will probably reach an all-time high in yield per acre. Field-run computations reached 716 bushels to the acre in several cases.

Contributing factors in this high yield are a rather general use of DDT which has prolonged plant growth by controlling leafhoppers; a cool moist August, favorable to potatoes, though not to other plants; and also the fact that a higher percentage of acreage is in the hands of specialized potato growers than ever before. (Oct. 4). HAROLD L. BAILEY.

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THE TETON POTATO: A NEW VARIETY RESISTANT TO RING ROT

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Ring rot caused by *Corynebacterium sepedonicum* (Spieck. and Kotth.) Skapt. has caused in recent years much concern among the potato growers of America. A zero tolerance in certified seed, the sterilization of seed knives, and other sanitary measures have done much to hold it in check. Despite such control measures losses from ring rot are far too common and reports of its inroads into new territory continue to be heard.

As soon as it became apparent that ring rot was a problem of major importance in the United States several of the cooperators in the National Potato Breeding Program undertook to produce varieties resistant to its attacks.

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The Wyoming program was initiated in 1939. All the commercial varieties produced in the state, together with a large number of seedlings obtained from the United States Department of Agriculture and some that had been produced at the Agricultural Experiment Station of the University of Wyoming were tested during the years 1940 to 1945.

The method used in testing for ring rot resistance consisted of smearing the freshly cut surfaces of the seed pieces with the bacterial ooze from ring-rot-infected tubers, then submerging the seed pieces in a water suspension of bacterial ooze from the same source. The seed pieces were planted by hand immediately after being inoculated. Readings for ring rot symptoms on the vines were made during the growing season. The vines and tubers from plants showing no ring rot at harvest time were examined by the ultra-violet-light and Gram-stain methods.

All commonly grown commercial varieties were susceptible but it was apparent that a number of the seedling varieties showed various degrees of resistance. Less than 2 per cent however showed this resistance to a high degree.

The Maine program was begun in 1939 and has been continued to the present. As a preliminary study in breeding for resistance to ring rot, as many as possible of the existing potato varieties were tested. Fifty-four named domestic and foreign varieties and many unnamed seedling varieties, both American and foreign, were included in the test. All but two of the named varieties were susceptible. A number of seedling varieties showed a high degree of resistance and since their discovery these have been used as parents in an attempt to obtain a higher degree of resistance and combine it with other characters of commercial importance.

The methods used in Maine were similar to those used in Wyoming. Slices of infected Green Mountain tubers were rubbed on the freshly cut surfaces of healthy seed pieces of the varieties and seedlings to be tested The inoculated seed pieces were planted immediately in the field. The plants were observed and then were dug after frost had killed the vines and the individual tubers were cut into slices and observed carefully for symptoms of ring rot A susceptible variety, usually the Green Mountain, is used for a control. Symptoms of ring rot were generally quite pronounced in both vines and tubers of the Green Mountain.

U. S. D. A. Seedling 47102, Teton, is resistant but not immune to ring rot It has been tested in both the Wyoming and Maine tests and

has been found to combine resistance with satisfactory yield, market and cooking quality.

Teton was first grown in Maine in 1934. It originated as the result of a cross between Earlaine and an unnamed seedling variety No 45146 The pedigree follows:

Teton (U.S.D.A. Seedling No. 47102)
- Earlaine
- U.S.D.A. Seedling No 45146
  - Katahdin
  - U.S.D.A. Seedling No 43752
    - U.S.D.A. Seedling No. 40568
      - Busola
      - Rural New Yorker No 2
    - U.S.D.A. Seedling No 38774
      - Busola
      - Carmen No. 3

Teton

Description

Plants.—Large, spreading; stems thick, prominently angled; nodes much swollen, green; internodes green; wings slightly waved, green; stipules medium to large, green, scantily pubescent; leaves long, broad, open, dark green, midrib green, scantily pubescent; primary leaflets ovate, large, 3 or 4 pairs, mean length 67.34±0.54 mm. (2.65 inches). mean width 44.92±0.41 mm. (1.77 inches), index 66.74±0.33 mm.[1]; peitoles green; secondary leaflets many, two positions—on midrib and primary leaflet petioles; tertiary leaflets many in number; inflorescence much branched, leafy bracts none; peduncles medium, green, scantily pubescent; pedicels medium, green, scantily pubescent.

Flowers.—With calyx lobe tips long, green, pubescent scant; cor-

olla medium in size 29-31 mm. (1.14-1.22 inches) diameter, color white; anthers orange-yellow, pollen abundant, good quality; style straight; stigma, globose, not lobed, green.

Tubers. — Round to oblong, slightly flattened; mean length 84.1 ± 0.57 mm. (3.31 inches)[2], mean width 77.6 ± 0.45 mm. (3.06 inches); mean thickness 61.0 ± 0.40 mm. (2.40 inches)[2] indexes, width to length 92.9 ± 1.06[3]; thickness to width 78.9 ± 0.76[3]; thickness to length, 72.1 ± 0.77[3], skin smooth, self-colored, light yellow. Eyes few and shallow, same color as skin, flesh white; sprouts creamy white when developed in the dark.

The Teton potato has been under observation at the Wyoming Agricultural Experiment Station at Laramie for the past six years, during which time it has been one of the most promising seedlings tested there.

Yield tests at Laramie showed that Teton outyielded Katahdin, on the basis of averages for the 3 years 1943 to 1945, but the differences among Teton, Irish Cobbler, and Triumph were not statistically significant as shown in table 1.

At the Torrington sub-station, Teton yielded 431 bushels per acre on the average for the three years 1943 to 1945 as you will note in table 2 Pontiac was its nearest competitor with an average of 357 bushels per acre. In the same test, Teton outyielded Triumph on the average 96 bushels per acre.

In Maine plant breeding tests Teton was outyielded by Green Mountain in the averages for four years. These results are given in table 3. You will note that the Teton yielded slightly higher than Chippewa and significantly higher than Katahdin and Sebago.

In a yield test conducted by Dr. Bonde in 1945 Teton yielded 492 bushels per acre as compared with 451 bushels for Green Mountain. Irish Cobbler, Sebago, and Katahdin yielded 378, 377, and 320 bushels per acre, respectively In this test Green Mountain,—long considered a

[1]Calculated by dividing the width by the length of each of 100 leaflets and multiplying the average of these ratios by 100 The leaflets were taken from the fourth leaf from the top of the stem, one leaflet, the distal left lateral, being taken from each leaf Since the potato leaflet is asymmetrical, the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described in the following work: Salaman, R. N. Potato varieties, pp. 163-170, Cambridge, 1926.

[2]The average of measurements of 100 tubers, each of a weight of approximately 8 ounces (223-133 g).

[3]Calculated by dividing the width of each 100 tubers by the length and multiplying the average of these ratios by 100. The data used for calculating the indexes were taken from the same measurements as those used to designate the dimensions of the tubers

TABLE 1.—*Teton, as compared in yield and percentage of U. S No 1 tubers with other varieties at Laramie, Wyoming*, 1943-1945.

Variety	U. S. No. 1 Tubers, Yield per Acre				U. S No. 1 Tubers Percentage Yield			
	1943	1944	1945	Ave	1943	1944	1945	Ave
	Bu.	Bu.	Bu.	Bu	Per cent	Per cent	Per cent	Per cent
Irish Cobbler	239	76	307	207	88	72	86	82
Triumph	282	53	295	210	88	59	89	79
Katahdin	227	49	259	178	88	52	81	74
Teton	259	64	281	201	89	65	88	81
Difference required for significance (odds 19:1)	39	17	35	18				

TABLE 2.—*Teton as compared in yield and percentage of No 1 tubers with other varieties at Torrington, Wyoming.* 1943-1945.

Variety	U. S. No. 1 Tubers, Yield per Acre				U. S No. 1 Tubers, Percentage of Yield			
	1943	1944	1945	Ave	1943	1944	1945	Ave.
	Bu.	Bu.	Bu.	Bu.	Per cent	Per cent	Per cent	Per cent
Teton	421	499	373	431	85	85	74	81
Irish Cobbler	394	288	135	272	85	66	44	65
Pontiac	378	460	232	357	86	77	64	76
Triumph	325	362	317	335	75	77	70	74
Pawnee	286	382	368	345	91	87	82	87

TABLE 3.—*Teton grown in Maine in comparison with some of the standard varieties.* 1942-1945.

Variety	1942 Yield U. S. No 1 per Acre	1943 Yield U. S. No. 1 per Acre	1944 Yield U. S. No. 1 per Acre	1945 Yield U. S. No. 1 per Acre	4-yr Ave Yield U. S. No. 1 per Acre	1942 U. S. No. 1	1943 U. S. No 1	1944 U. S. No 1	1945 U. S. No. 1	4-yr Ave. U. S. No 1
	Bu.	Bu.	Bu.	Bu.	Bu.	Per cent	Per cent	Per cent	Per cent	Per cent
Green Mountain	273	556	374	410	403	94	99	97	94	96
Katahdin	216	479	244	347	322	95	98	95	95	96
Chippewa	233	523	333	380	367	92	98	97	93	95
Sebago	197	498	301	373	342	91	98	93	94	94
Teton	243	512	350	380	371	95	98	98	94	96
Difference required for 5 per cent level of significance	40	63	33	60	25					

TABLE 2.—*Teton as compared in yield and percentage of No. 1 tubers with other varieties at Torrington, Wyoming.* 1943-1945.

Variety	U. S. No. 1 Tubers, Yield per Acre				U S. No 1 Tubers, Percentage of Yield			
	1943	1944	1945	Ave.	1943	1944	1945	Ave
	Bu.	Bu.	Bu.	Bu.	Per cent	Per cent	Per cent	Per cent
Teton	421	499	373	431	85	85	74	81
Irish Cobbler	394	288	135	272	85	66	44	65
Pontiac	378	460	232	357	86	77	64	76
Triumph	325	362	317	335	75	77	70	74
Pawnee	286	382	368	345	91	87	82	87

TABLE 3.—*Teton grown in Maine in comparison with some of the standard varieties.* 1942-1945.

Variety	1942 Yield U. S No. 1 per Acre	1943 Yield U. S. No. 1 per Acre	1944 Yield U. S. No. 1 per Acre	1945 Yield U. S. No. 1 per Acre	4-yr. Ave. Yield U. S. No 1 per Acre	1942 U. S. No. 1	1943 U. S. No. 1	1944 U. S. No. 1	1945 U. S. No. 1	4-yr. Ave. U. S. No 1
	Bu.	Bu.	Bu.	Bu	Bu.	Per cent	Per cent	Per cent	Per cent	Per cent
Green Mountain	273	556	374	410	403	94	99	97	94	96
Katahdin	216	479	244	347	322	95	98	95	95	96
Chippewa	233	523	333	380	367	92	98	97	93	95
Sebago	197	498	301	373	342	91	98	93	94	94
Teton	243	512	350	380	371	95	98	98	94	96
Difference required for 5 per cent level of significance	40	63	33	60	25					

heavily yielding variety in Maine,—produced 41 bushels less than Teton. Furthermore, 20 per cent of the Green Mountain tubers developed net necrosis,—a condition that was not noted in the new variety

Cooking tests made in cooperation with the Home Economics Department of the Wyoming Experiment Station at Laramie showed that the Teton was superior to Triumph and Irish Cobbler when baked The flesh was moderately mealy and moderately coarse to fine grained having a normal pleasant flavor When boiled, Teton was superior to Triumph but slightly inferior to the Irish Cobbler. The flesh was mealy and moderately coarse grained. The color would be classed as white in the commercial trade but it is in reality pale creamy white.

Cooking quality has been found to be highly correlated with dry matter content since many people in the United States prefer dry potatoes for either baking or boiling The dry matter content of Teton as compared with seven well-known standard varieties grown in the yield tests on the Aroostook Farm, Presque Isle, Maine, are given in table 4

TABLE 4.—*Dry matter content of Teton as compared with 7 well-known standard varieties. Data from tubers grown in the yield tests on Aroostook Farm, Presque Isle, Me.* 1942-1945.

Dry Matter Classes[1]

Varieties	1942 No.	1943 No.	1944 No.	1945 No.	Average No.
Teton	6.8	6.0	4.4	7.2	6.1
Triumph	5.8	4.8	4.4	5.3	5.1
Russet Burbank	—	8.4	5.5	6.0	—
Green Mountain	9.8	8.9	6.2	8.0	8.2
Mohawk	9.5	9.8	6.1	7.3	8.2
White Rose	7.4	7.2	4.0	5.6	6.1
Irish Cobbler	7.4	7.9	—	7.5	—
Katahdin	7.2	6.4	4.4	5.3	5.8
Difference (Odds 19:1)	0.8	1.3	0.6	0.7	0.4

Dry Matter Class	Specific Gravity
1	1.060
2	1.065
3	1.070
4	1.075
5	1.080
6	1.085
7	1.090
8	1.095
9	1.100
10	1.105

Dry matter classes based on approximate specific gravity determinations.

It can be seen that dry matter content varies from year to year. The average for Teton for the four years was not so high as that for Green Mountain or Mohawk, but was high enough to indicate good quality.

Teton has been tested for its reaction to ring rot in Wyoming and Maine. In replicated trials in Wyoming it was found to be highly resistant. During the first four years, 1940-1943, the infection varied from 0.0 to 1.03 per cent, whereas the Triumph checks showed 24 to 100 per cent with an average of 73 per cent infected plants.

At Laramie, in 1944, seed pieces of Teton were inoculated and planted in 40-hill rows replicated seven times Questionable ring rot symptoms were found in 4.4 per cent of the plants, whereas the Triumph checks showed 46 per cent of the plants with definite ring rot infection. Ten out of about 2,000 tubers of Teton examined, or approximately 0 5 per cent, showed ring rot symptoms. In a similar test in 1945 the infection was somewhat more severe. In this test an average of about 8 per cent of the Teton plants showed ring rot, whereas 90 per cent of the Triumph plants were infected. When the tubers were examined it was found that 4.6 per cent of the Teton tubers were infected, whereas 55 per cent of the Triumph tubers had contracted the disease.

TABLE 5.—*The ring rot reaction of Teton in comparison with that of Green Mountain and Katahdin on Aroostook Farm, Presque Isle, Maine*, 1940-1945.

Year	Teton	Ring Rot Plants Green Mountain	Katahdin
	Per cent	Per cent	Per cent
1940	0	100	100
1941	1	72	86
1942	0	80	82
1943	0	65	90
1944	18	72	95
1945	3	68	80

The results of the tests at Aroostook Farm, Presque Isle, Maine, corroborated those found in Wyoming. The data for the Maine tests are given in table 5. In one test 50 seed pieces were inoculated by rubbing their freshly cut surfaces with slices of infected Green Mountain tubers. None of the Teton plants became infected but Green Mountain and Katahdin controls were practically all diseased as a result of similar inoculations No infected Teton plants were found in 1940, 1942 and 1943, and only 1 per cent in 1941. In 1944, however, 18 per cent of the

plants became infected and 3 per cent in 1945. These percentages are low however, in comparison with the percentages of infected plants found in Green Mountain and Katahdin. It should be mentioned that the Teton seed stock was used for 3 successive years from 1943 to 1945. During this three-year period Teton showed no active decay and the disease was difficult to find in the plants. The Green Mountain and Katahdin controls were badly decayed and they have never survived the inoculations for more than one year.

In a test conducted by A. C. Foster at the Plant Industry Station, Beltsville, Maryland, a number of Teton plants became infected with the disease.

It is apparent then that Teton is not immune, but the results in Wyoming and in Maine show that it is highly resistant to ring rot.

About 5,000 bushels of certified seed of Teton were available in Wyoming for the 1946 planting, but the variety has not yet been increased for distribution in Maine.

It should be emphasized that Teton is not immune to ring rot, and just as much care should be practiced in growing a crop of this variety as is recommended in growing very susceptible varieties. The best certified seed should be secured It should not be handled in old bags or other containers that have been in contact with potatoes infected with ring rot The cutting knives should be sterilized.

The big advantages of Teton over susceptible varieties are that this variety becomes infected with ring rot much less readily than the commonly grown commercial varieties and the percentage of tubers, even under optimum conditions for infection, is very small and the disease spreads very slowly. The big disadvantage is that if the seed stock once becomes infected it may be more difficult to clean it up than it would be to eradicate the disease from a more susceptible variety since the symptoms on both vines and tubers of Teton are not so conspicuous as they are in other varieties. If ordinary sanitary precautions are adhered to, however, Teton should be valuable in districts where ring rot is a serious menace to potato production.

Summary

Teton has shown a high degree of resistance to ring rot over a period of years in Wyoming and Maine. It is not immune from the disease. It produced satisfactory yields in tests in both Wyoming and Maine. In cooking tests made in cooperation with the Home Economics Department of Wyoming Experiment Station, Laramie, Teton was superior to Triumph and Irish Cobbler when baked. When boiled, Te-

ton was superior to Triumph but slightly inferior to Irish Cobbler. Tests for dry-matter content in Maine showed Teton to be lower in this respect than Green Mountain and Mohawk but high enough to indicate good cooking quality.

If ordinary sanitary precautions are adhered to, Teton should be valuable in districts where ring rot is a serious menace to potato production.

POTATO YIELDS FROM DIFFERENT POTATO LEAFHOPPER DENSITIES[1]

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and
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The importance of injuries by the potato leafhopper, *Empoasca fabae* (Harr.), in potato production, although generally recognized, is yet insufficiently understood. This is especially true where but few of these inconspicious insects are present The effect of a few leafhoppers is, moreover, ofter obscured by attacks of other insects and by diseases which cause reductions of potato yields Often these cause such severe damage as to render the injuriousness of *E. fabae* of little importance by comparison.

In view of all of the research conducted with the potato leafhopper, it would appear that some data should have been published evaluating the importance of different densities of the leafhopper in affecting potato yields. Such data, however, appear to be lacking,—possibly because of a number of factors. Among these is the difficulty of controlling populations on a sufficiently large number of potato plants to give differences in yields If plants were caged and the desired number of insects introduced, the changed environmental conditions caused by confinement might make the results of questionable value from the viewpoint of field, or practical conditions An alternative method of evaluating different leafhopper densities is through control of the insects by another means, *e.g.*,—by some chemical treatment. Attempts have been reported by Skaptason and Blodgett (1941), Sleesman and Wilson (1943), and by

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[3]Associate Research Professor, Plant Pathology.

Wolfenbarger (1936) to use this method in the association of leafhopper abundance on yields of field plots. The evaluation of leafhopper effects appears particularly enhanced by the use of the new organic insecticide DDT.

The efficiency of DDT in controlling the potato leafhopper is recognized through the reports of Granovsky (1944), Heuberger and Wolfenbarger (1944-a-), Wilson and Sleesman (1945), Wolfenbarger, *et al* (1945) Wilson (1945), and Heuberger and Stearns (1946). Increased size of plants and larger leaves resulting from the use of DDT was noted by Heuberger and Wolfenbarger (1944-a-) and also by Wilson and Sleesman (1945). In the process of applying the treatments, DDT drifted to adjoining and nearby rows. Effects of DDT drift to these rows was recorded by Heuberger and Wolfenbarger (1944-a-) and also by Wilson and Sleesman (1945). The last mentioned publication gave quantitative effects of distances to which DDT drifted Effects up to at least 8 feet were reported. Reference will be made to these data later.

Studies of the authors' data by graphic means showed that sharply increased yields were indicated as the counts of leafhoppers became lower, and approached zero. It was found that linear relationships became apparent, if the variables—leafhopper densities and yields, were plotted on logarithmic paper. Relating potato yields to insect infestations or injuries is not especially new. Bald and Helson (1944) in Australia observed that, ". . . healthy potato plants, grown under uniform cultural conditions and not infested by the potato moth, yield approximately in proportion to their leaf area." They showed that potato yields were directly related to the leaf areas of potato plants as results of injuries from the potato tuber moth, *Gnorimoschema operculella* (Zell.), when yields and leaf areas were plotted on logarithmic graphs.

The authors' data, Wolfenbarger *et al* (1945) and Heuberger and Stearns (1946) illustrate the rates of yields associated with different leafhopper densities Data on leafhopper abundance and yields were converted to logarithms, and used in the calculation of regression curves by the regular method of least squares computation. These curves are presented in figure 1. The effects of the different test materials, other than the influences on leafhopper populations and yield, are ignored in the presentation of the curves in figure 1 The curves are noted to have similar rates of slope. The computed rates of reduction in potato yields on leafhopper densities are log —0 1636, —0 1003, —0.3048 for 1944 "early", and "late", and 1945 "early"

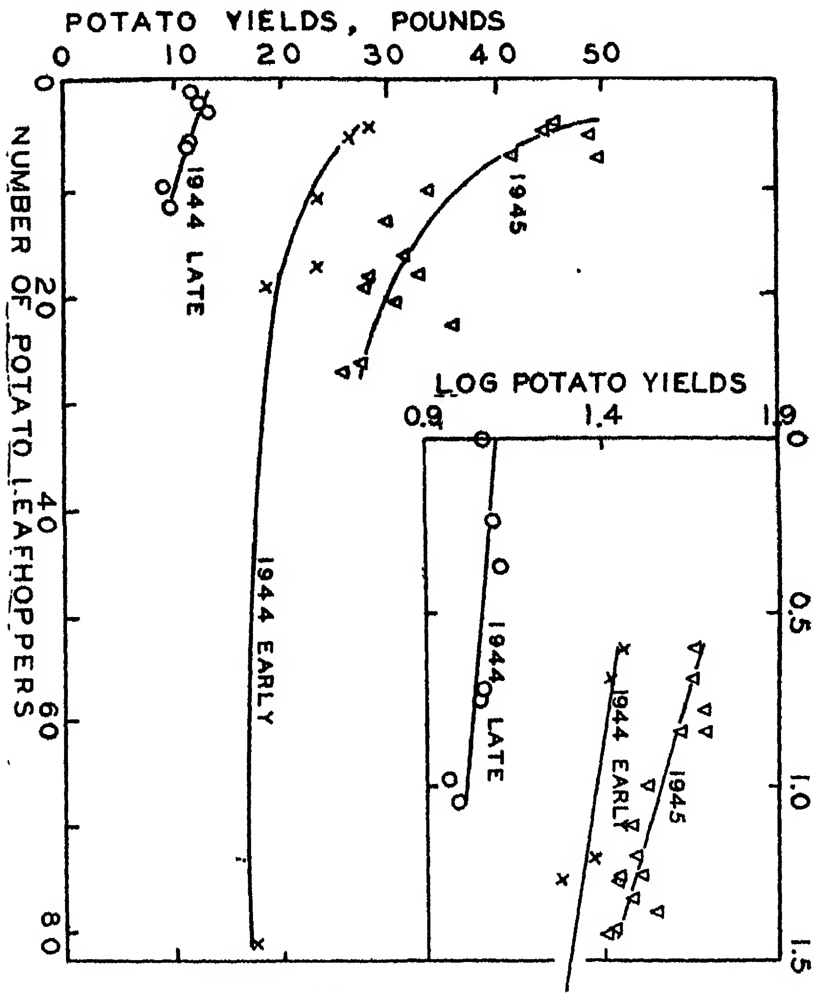

FIGURE 1. Rates of influence of potato leafhopper abundance on potato yields in Delaware.

plantings, respectively. Agreements of the observed and the computed values are sufficiently close for each curve so that they are statistically significant Although there were a few potato flea beetle injuries on these plants, aphids and plant diseases were of no consequence in reducing the yields.

Leafhopper densities and yields are significantly related, with increasingly greater yields from lower than from higher densities These curves show that the reduction of large populations of leafhoppers in-

creases the yield. Furthermore, they indicate that elimination of the total population is much more effective in increasing yield than the control of, for example, 85 per cent of a dense population.

Studies were made of data reported by other workers to determine whether they follow similar rates of yield change with changes in leafhopper infestation. When the data of Skaptason and Blodgett (1941), Sleesman and Wilson (1943), Gui (1945), and Wilson (1945) were

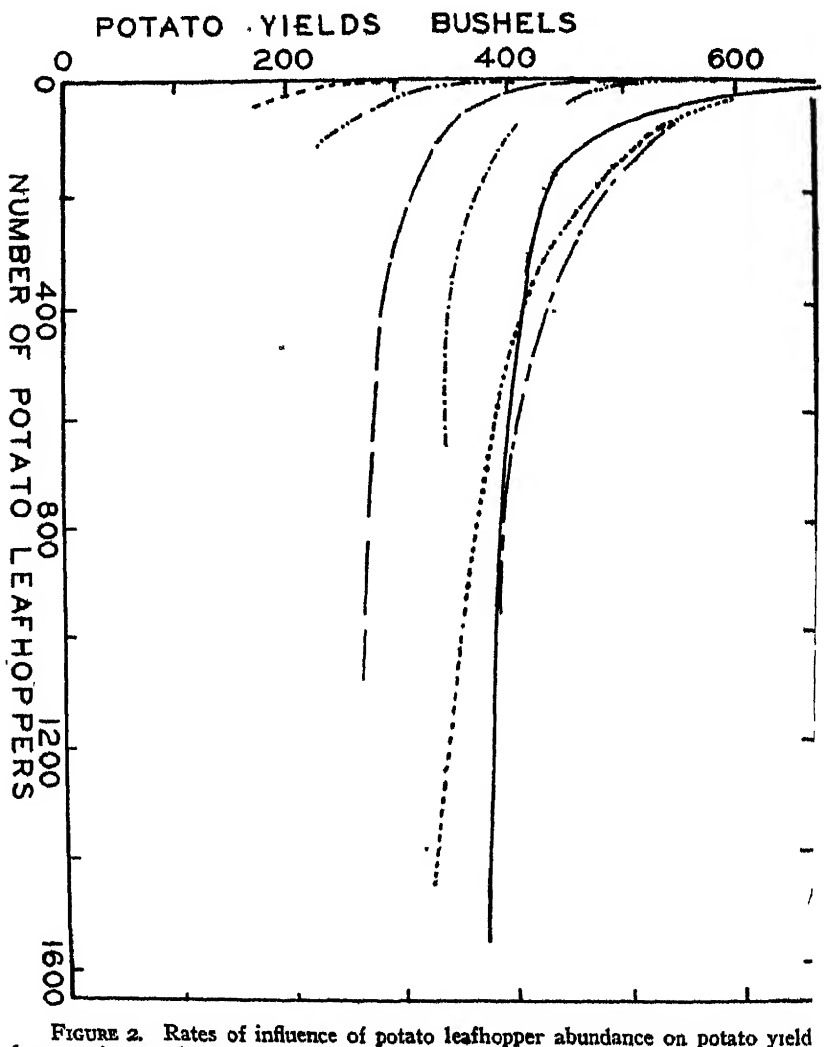

FIGURE 2. Rates of influence of potato leafhopper abundance on potato yield from various authors.

*For explanation of graph see page 394.

examined, marked effects in the rates of yield change as related to leafhopper density levels were revealed. Their data were changed to logarithms, from which curves were determined. The results are shown in figure 2. In figure 2, the relationships are presented in regular graph form and show the rates of curvature. It is accepted that different yields are obtained from plants in different growing locations, regardless of the density level of potato leafhoppers. Emphasis is directed, rather, to the slopes and to their similarity, regardless of origin or location. Smoothed curves are given without the observed values, since the details would occupy much space, contribute to confusion, and detract from the factors being considered. The slopes are determined from work done under field conditions in rather widely separated locations, under different climatic conditions, and by different workers.

A further indication of the similarities of different leafhopper densities in causing similar reductions in potato yields is seen in the regression coefficients computed to determine the curves in figure 2. These are given in table 1. In presenting these figures, it is realized that different rates of yield reduction may be expected in different localities, years, and under different conditions, made variable by several other factors.

TABLE 1—*Regression coefficients from the different data on potato yields as related to potato leafhopper density levels.*

Source of Data	Coefficients
Skaptason and Blodgett (1941)	—0.0735[1]
Wilson (1945)*	—0.0623[2]
Sleesman and Wilson (1943) (table 9)	—0.1410[2]
Sleesman and Wilson (1943) (table 5)	—0.0044[2]
Wolfenbarger, *et al* (1945) (Late)	—0.1003[1]
Wolfenbarger, *et al* (1945) (Early)	—0.1635[2]
Heuberger and Stearns (1946)	—0.3094[2]
Wilson and Sleesman (1945) (table 2)	—0.1648[2]
Wilson and Sleesman (1945) (table 1)*	—0 0283[1]
Gui (1945) Marietta location	—0 1908[2]
Gui (1945) Wooster location	—0 1937[2]
Average	—0 1384

1—A statistically insignificant coefficient.
2—A statistically significant coefficient

The average coefficient, log —0.1384, has a standard error of —0 0075. It illustrates the rate of reduction of yields as affected by leafhopper densities. A further illustration is shown by an hypothetical

*Figures of 0.01 leafhoppers were taken for the zeros given, for computational purposes.

example in which a 100-bushel-per-acre yield was obtained from plants having a leafhopper density level of 10. From these figures, one might expect the following:

Potato leafhopper density level	0.1	1.0	10.0	100.0	1,000.0
Yield, bushels per acre	189	138	100	73	53

In tests of fungicidal materials on early potatoes where DDT was not used, reported by Heuberger and Wolfenbarger (1944), the leafhopper infestations ranged from 24 to 160 on 16 leaves. Although the yield trend was greater where the leafhopper counts were less, the yields were insufficiently great (due to droughty conditions) to illustrate differences as marked as those reported above for plants treated with DDT. It appears from these tests and from data on other materials used in past years for leafhopper control that, although such materials reduced the leafhopper populations considerably and increased the yields somewhat, they did not reduce the infestations sufficiently to illustrate the extremely marked effects of low populations of the leafhopper on potato yields.

In the references given, it was observed that some of the leafhopper counts were reported in terms of the insects collected by sweep nets and, in others, by counting the nymphal forms. The comparative efficiencies of insecticide treatments can doubtless be measured by either method. For more exact determinations of relationships of leafhopper densities and yields, both adults and nymphs should be recorded. Although DDT is excellent for controlling nympth and adult populations, adults may attack treated plants and feed for a time before they perish. The effects of these attacks, unless the sample counts include adults, may not be understood.

SUMMARY. — Different potato leafhopper densities are shown to affect the yields of potatoes at an average of log —0.1384 per log of leafhopper density. Data show that one leafhopper in a light infestation is much more injurious than one in a heavy infestation. The use of DDT has enabled research workers to determine how much more injurious a few leafhoppers are than has heretofore been thought.

* *Author*		*Curve Symbol*
Skaptason and Blodgett		—— — —— — —— —
Gui, Marietta		—— -- —— -- —— --
Wooster		—— —— —— —— —— ——
Wilson, table 3		————————————
Wilson and Sleesman,	table 1	-- —— -- —— -- ——
do.	table 3	- - - - - - - - - - - - - - - - - - - -
do.	table 5	—— —— —— ——
do	table 9	—————— — —————— —

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EFFECT OF STAND PERCENTAGES AND SKIPS IN STAND ON YIELD OF IRISH POTATOES IN LOUISIANA[1]

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Under the humid conditions prevailing in southern Louisiana, a perfect stand of Irish potatoes is difficult to obtain. Occasionally the reduction in stand, that is, the amount of row space comprising gaps of different lengths, is of appreciable magnitude. Obviously these variations in stand affect the yield of No 1 tubers.

[1]Cooperative investigations of the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, and the Louisiana Agricultural Experiment Station, Baton Rouge, La

[2]Pathologist.

From the standpoint of the commercial grower, as well as the investigator who makes field experiments with potatoes, it is essential to know the growth response to such variations in order that the relative importance of any error resulting from them may be determined.

The studies herein reported were undertaken to determine the relation of (1) plant number (stand percentage) and (2) skips in stand of various lengths to yield of No. 1 tubers.

Methods and Materials

In all experiments certified seed of the Triumph variety was used, and the seed pieces were carefully cut to weigh about 1½ ounces. After the plants were about 4 to 5 inches high the required plants were removed from the respective plots to make up the desired stand percentages or skips in stand of various lengths. In doing this the plants that were to be removed were selected by use of random numbers, and this selection of random numbers was done in the office before going to the field. Both of the experiments dealing with plant number were made at Baton Rouge, Louisiana, in 1943 and 1945. Three experiments were made to study the effect on yield of skips in stand of various lengths; one in 1942 at Lafayette, Louisiana, and two at Baton Rouge, Louisiana, in 1944 and 1945.

In the experiments on plant number as related to yield the plots were 40 hills (12-inch spacing) in length and were arranged as complete-randomized blocks consisting of six replications in 1943 and five replications in 1945. In 1943 the initial stands of the various plots were so affected by cool wet weather that neither a 90-per cent nor a perfect (100-per cent) stand could be obtained.

With regard to the three experiments dealing with skips in stand of various lengths, the plots were 30 hills (12-inch spacing) in length and were arranged as complete-randomized blocks. The number of replications for each test was as follows: 1942, 10 replications; 1944, 6 replications; and 1945, 9 replications. The skip combinations, each of which totaled 144 inches of row space, were as follows: 6 single skips, 4 double skips, and 3 triple skips per plot.

Experimental Data

Effect of Plant Number on Yield

The effect of plant number, that is, different percentages of stand, on yield of U. S. No. 1 tubers is presented in table 1. From these data it is apparent that the trend is for a progressive decrease in yield as the percentage of stand decreases.

Linear regression coefficients calculated for each of the tests were found to be significant, whereas quadratic regression relationship was not significant. Thus, within the observed limits, it appears that the relationship between percentage of stand and yield is a linear one, although it is recognized that had the observed limits been extended this relationship might be non-linear.

The linear regression coefficients for these tests were found to be +0.73 bushels for 1943 and +1.87 bushels for 1945. Thus, each increase of 1 per cent in stand resulted in a corresponding increase of 0.73 bushels to 1.87 bushels of U. S. No. 1 tubers per acre.

Using these regression coefficients the observed yields were adjusted for each respective 10-per cent stand group. These data are presented in table 1.

TABLE 1.—*Effect of different percentages of stand on the yield of U. S. No. 1 Triumph potatoes at Baton Rouge, Louisana, in 1943 and 1945.*

Stand	Yield of U. S. No. 1 Tubers per Acre			
	1943		1945	
	Actual	Calculated	Actual	Calculated
Per cent	Bushels	Bushels	Bushels	Bushels
30	63.1	62.2		
40	70.3	69.4		
50	75.9	76.7		
60	80.7	84.0	180.4	187.4
70	92.2	91.3	214.3	206.1
80	100.0	98.6	227.7	224.8
90			241.7	243.5
100			260.1	262.2

Effect of Skips in Stand of Various Lengths

The data given in table 2 indicate that some types of skip-combinations had a marked influence on the yield of U. S. No. 1 tubers, even though the amount of row occupied by skips was the same in each skip-combination. The yield of plots consisting of four double skips was significantly lower than that of six single skips. On the other hand, the difference in yield between three triple skips and four double skips, although considerable,—was not significant in 1942 and 1944, but was

TABLE 2.—*Yield of U S No. 1 Triumph potatoes from plots in which the stand had been adjusted to different numbers and sizes of skips (each skip-combination totaling 144 inches of row space) at Baton Rouge, Louisiana.*

Year	Skip-combination and Yield per Acre[1]			
	None (100 per cent Stand)	6 Singles (80 per cent Stand)	4 Doubles (73 3 per cent Stand)	3 Triples (70 per cent Stand)
	Bushels	Bushels	Bushels	Bushels
1942	..	156 1	137 8	123.7
1944	....	263 3	239.2	219 4
1945	208 1	182 1	165.5	150 7
Average	....	200 5	180 8	164.6

[1]Difference required for significance (5 per cent point) in 1942=16.7 bushels.
Difference required for significance (5 per cent point) in 1944=24.2 bushels.
Difference required for significance (5 per cent point) in 1945=11 5 bushels.

in 1945. The plants adjacent to skips in the plots with 6 single skips in 1945 did not increase enough in size to compensate for the yield loss from reduction in stand. This is apparent since the difference in yield with 6 single skips was significantly lower than that obtained from a perfect stand (100 per cent). On the whole, short skips reduced the yield much less than equivalent space in larger skips.

SUMMARY AND DISCUSSION

The studies herein reported were conducted near Lafayette and Baton Rouge, Louisiana. The object was to determine the relation of plant number (stand percentage) and of skips in stand of various lengths to yield of U. S. No. 1 potatoes.

The relation of plant number (stand percentage) to yield was found to be a linear one, within the observed limits of stand percentages. It was determined that each increase of one per cent in stand resulted in a corresponding increase of 0.73 bushels in 1943 and of 1.87 bushels in 1945.

Some types of skip-combinations had a marked influence on yield even though the amount of row occupied by the skips was the same in each skip-combination. A skip in the stand of potatoes does not necessarily result in a reduction in yield equivalent to the normal production of the area of land involved.

These results emphasize the necessity of uniform stands of potatoes for commercial growers as well as for investigators making field yield tests. Since the regression of yield on stand was linear, within the ranges of stand considered, one can adjust yields to a uniform stand basis for variety or treatment comparisons. Of course, it should be remembered that with a wider range of stand this relationship probably would not be maintained.

The attainment of uniformity of stand involves a great many field practices. The principal operations are those preceding and immediately following planting and, to a somewhat lesser extent, later cultivation and protection against diseases and insects.

SECTIONAL NOTES

IDAHO

Potato harvest is practically complete except for the Twin Falls,—where it is estimated that 30 to 40 per cent of the potatoes are still in the ground, in the seed area in Lewis and Nezperce counties,—in the Jerome section,—where harvesting is only about one-half completed. The yields, in general, have been above last year. The tubers are also larger and among them are more rough tubers and bottle necks. Our seed potatoes, for the most part, grew to a much larger size than last year and when the bakers are sorted from the seed there will probably be considerable less actual certified seed than last year. Some frost damage, (as high as 5 per cent) was reported in the higher altitudes of Eastern Idaho. There will probably be some small loss caused by frost in the Twin Falls in the Jerome area where harvest is not complete.

Harvesting operations not only have been slow and difficult because of poor harvesting weather but also principally because of shortage of labor Most growers reported that labor shortage was much worse this year than any previous year.

The acreages of seed potatoes that passed final field inspection are less than those of last year although the yields are higher,—but a larger proportion of the seed crop will be sorted out and sold as commercial. (Oct. 29).—John R Robertson.

INDIANA

The potato harvest for Indiana was one of the best we have had in years. There were excellent yields of good to best quality potatoes. Most of our merchants ran specials on Indiana potatoes and sold many

an extra bag for winter use. Nearly every one appeared to be happy about the situation. The grower did not complain, the merchant sold quality, and the purchaser paid cash.

Seed dealers are again contacting growers for next year's seed supply and I presume we will use about as much seed stock as before.

Although we do not recommend commercial potato production on sandy soils, we do find that some homemakers can produce sufficient potatoes for family use and a few extra when planting dates and varieties are taken into consideration. The Sequoia topped the yields over seven other varieties at the rate of 193 bushels per acre; Katadhin, 145; Chippewa, 140; Sebago, 90; Russet Rural, 56, and Red Warba, 51. Menominee and 528-170 were hardly worth checking. The records on better soils rank in approximately the same order. (Oct. 21).—W. B. Ward.

NEBRASKA

The harvest in Nebraska is about as late as the writer can recall. The extreme lateness has been caused by a great deal of inclement weather. Since the first of October, there has been a continuation of rain, snow, sleet and cold weather to prevent the regular progress of harvest. A very few growers, whose potatoes matured early, were able to get their crop harvested in the first few days of the month. The balance of the crop, however, due to extreme lateness of the season, was too immature to dig, and ran into the bad weather.

As a result of this inclement weather, the harvest was so delayed that an occasional half day was all that most growers could dig and pick. Even then, the potatoes were "mudded" out of the ground, and will be difficult to grade during the winter.

On the 19th of October, the weather finally broke, and there was an almost unbroken period of a week that was warm and favorable. Many growers then indulged in wishing that they had waited for this good weather. The long time weather data, however, pointed to the danger of digging after the middle of October. Serious freezes are likely to damage many of the potatoes in the ground, with the subsequent difficulties of handling such stock in the cellars. During the week of the 21st of October, the wheels turned satisfactory, and the bulk of the crop was put under cover At this writing, (October 28) very few potatoes remain in the ground, and we have worked out of what resembled a hopeless situation.

Owing to the size of the crop over the country generally, prices on both certified and table stock remain at a fairly low point. There

was a temporary splurge in the table stock market during the past week, because of the few offerings from this western area. The prices on certified potatoes have not been established, owing to the fact that growers were reluctant to make quotations while the bulk of the crop was still unharvested. This situation is expected to change rapidly during the coming week, as most of the growers will know what their general outlook is for quality and production.

Owing to the extreme difficulties in the harvest, many growers at this writing claim they will cut down their acreage for next year. This of course, will remain to be seen, and will depend much upon the success of marketing the present crop. (Oct 28.)—MARX KOEHNKE.

NEW YORK

New York growers generally, finished digging the week of the 20th of October. Many completed before that time. The crop was generally good and most of it found storage.

County officials report the biggest influx of applications for loans that have been experienced to date. The market is about 40 cents under the support price as of the 30th of October and growers realize that they can make 40 cents per cwt. pretty easily by not selling.

Markets are expected to improve after the 1st of November, because of the increase in support prices and because most of the surplus potatoes ought to be under cover.

About 90 per cent of the New York potatoes going to market are in paper consumer packages. There has been a tendency in this direction for several years and this fall burlap bags are seldom seen.

New York will not have too big a crop of good certified seed. Our acreage was increased and our yield per acre is higher than average but we have had a bigger loss of acreage than usual. There is also a bigger demand for seed potatoes in New York State because so many growers have decided that next spring is the time to change their seed. It is the custom in this state for many growers to use their own seed for several years in succession,—renewing their seed only when prices are low.

Despite the theoretical large yield per acre the seed crop is remarkably uniform in size due to the fact that seed growers for the last few years have been planting very closely thus not only increasing the number of tubers per acre but keeping the size down. Many growers plan to grade in two sizes this year, 1⅞" to 2½" and 2½" to 3¼".

Some of the new varieties have shown up very well Erie produced an excellent set of uniform sized tubers. This variety shows some re-

sistance to scab and blight and may find a prominent place in the potato picture. Ontario, the new scab-resistant seedling proved to be not only scab-resisctant but an excellent yielder of high quality, shallow-eyed, white tubers. Sequoia also did well for itself and where seed pieces were planted close together has probably produced the highest yield per acre. This variety is also gaining in popularity because of some blight resistance and its high yielding tendencies. Its biggest drawback is oversize tubers. Some certified seed of all three of these varieties will be available this year. (Nov. 2).—H. J. EVANS

NORTH DAKOTA

North Dakota's 1946 crop of certified seed potatoes has developed under ideal weather conditions. "In quality, the crop is a recordbreaker!" according to R. C. Hastings, State Seed Commissioner. "The potatoes came out of the ground, smooth, firm, and bright. Thousands of acres were entirely free from any form of virus disease."

North Dakota's location above the 47th parallel north is unusually favorable for growing seed potatoes. The climatic conditions are less conducive to the development and spread of seed-borne diseases. Then, too, the growers stepped up their efforts this year, to keep up the high certification standards established in North Dakota This state has been at the top or near the top in the production of seed potatoes for the past ten years. This year, growers wanted to be at the top and stay there. "Carlots of North Dakota seed potatoes are rolling into the Eastern Seaboard daily. This should bring a lot of good seed potatoes here for the use of local growers." (Nov 15.)—GRACE HUDSON.

NEW JERSEY

The New Jersey potato crop is, at present, almost completely harvested It is believed that very few potatoes are being held in storage this year because of the generally favorable price existing during the past month. The quality of the potato crop has been excellent, with a very large percentage grading U. S. No. 1.

The potato acreage goal for the Department of Agriculture for New Jersey is divided into Early and Late acreages,—47,300 acres have been allotted to the Early Commercial acreage and 8,900 to the Late or non-commercial acreage, a total of 56,200 acres This is a reduction of approximately 17 per cent from the 68,000 acres planted this year and 3 per cent less than the average acreage for the years 1935-'44.

The fact that all growers, who plant more than their allotment will be penalized by being made ineligible for price support may not be sufficient penalty to keep many growers from overplanting. Growers

with high yields sold potatoes under support prices both this year and last in order to move their potatoes. These growers might be inclined to take their chances on a low market price and not reduce their acreage This would result in over production and a glutted market requiring the government to purchase a larger percentage of the potatoes grown by those who plant within their goal.

The Trustees of the State Potato Association adopted a resolution, on October 18, stating that the growers could cooperate in a program to reduce acreage—provided—that the support program was amended to permit certified dealers and growers to sell at the market price.--requiring the government to pay the grower the difference between the market price and the support price. It was further suggested that the market price should be supported at 50 or 60 per cent of parity to prevent the price from collapsing completely in the event of excess production.

This plan might deter the growers from overplanting if they knew that the government would not try to keep the market price up to 90 per cent of parity. This plan would also substantially reduce the cost of the government.

OREGON

The harvesting of our commercial potatoes was delayed by lack of labor and our harvesting period is now running into freezing weather. The main potato sections,—Central Oregon and Klamath County,—have an excellent crop. The acreage in Central Oregon is about 10,000 and in Klamath County, approximately 18,000. It is hoped that our harvesting operations will be completed soon after the first of November. All our storage facilities will be filled with this crop.

A special effort was made to improve the quality of Oregon certified seed by making three field inspections this year. There were 5,500 acres entered for certification,—with approximately 50 per cent of the acreage passing field inspection. Leafroll was the cause of more than 30 per cent of our rejections and withdrawals. It is anticipated that the additional inspection this year will result in a considerably better quality of seed (Oct. 4).—W. G. NIBLER.

RHODE ISLAND

Rhode Island potato growers have just completel harvesting a record potato crop of excellent quality. It has been necessary to place part of the crop in temporary storage due to a lack of sufficient permanent storage.

Nearly 100 per cent of the commercial growers used DDT for

insect control. Without doubt this is partly responsible for the record crop.

The twelve inch rainfall in August threatened to bring on a blight epidemic, but the commercial growers held the blight in check with frequent sprays of bordeaux mixture Some growers applied at least 15 sprays. The excellent weather in late September and October dried out the soil, and it kept the blight from spreading late in the season. Therefore, very little tuber rot was found at harvest time.

Several thousand bushels of potatoes were purchased through the P.M.A. support program, and were sold to farmers for dairy and hog feed Some of the potato growers are participating in the storage loan program also (November 7).—AVERY E. RICH.

WASHINGTON

The certified seed potato crop in the state of Washington is practically harvested and the majority of the crop is in storage.

About 50 per cent of the White Rose has been sold but subject to the California winter test for disease. As a result, this seed is being stored in the producing area. The potato crop, in general, of both White Rose and Netted Gems in Washington was above the average,—both in acreage and production per acre. However, because of the slump in the market this Fall, planting intentions for both commercial and seed potato will be below average for 1947.

The use of DDT as an insect control has proved very satisfactory, and particularly in the Netted Gem areas where current infection of leaf roll has resulted in net necrosis in the tubers. Evidently, the insect control has indirectly been a very efficient control of disease spread. This result may bring a return of larger acreages of the Netted Gem variety in proportion to the total crop. (Oct. 25).—CHAS. D. GAINES.

WASHINGTON

The harvesting of approximately 860 acres of certified White Rose seed potatoes has been completed in Whatcom County,—this being the only county in the state where this variety is grown for seed. The average yield is nine tons per acre with several fields yielding as high as 18 tons per acre. This year DDT dust has played an important part in holding the aphid population to practically *none*. We do know that the aphid population has not been a serious menace as compared with last year. However, those present were destroyed by the application of the DDT dust. Where Late Blight was a problem the Basic Copper Sulphate was used in combination with the DDT,—with excellent results being obtained.

The 29th of September was a big day for several growers when the shipment of 40 cars of White Rose certified seed left from the Port of Bellingham for Argentina, South America. The crated potatoes were held on the docks in storage for 20 days awaiting the arrival of the ship which was held up by the maritime strike. The cost of $1.00 each for crates and the scarcity of material made shipping to the Argentine almost impossible.

This season the growers were again able to purchase Calcium Cyanamid for killing vines. Several fields were killed at 70 days from planting time, whereas others were left for 100 days. Experience has proved that early killing of the vines during the past season cut down the possibility of latent virus infection. Additional materials that were used during the past year were monohydrated copper sulphate and Dow 66.

Sampling for the Oceanside, California, test plots was supervised by the State Inspectors this year. Two hundred ten tubers of an average of three ounces in size were taken from each 20-acre field or less These tubers will be planted at the plots in units of two's,—the first week in November. This will enable the growers to obtain the disease readings by February. In addition to Oceanside testing the foundation lots of seed are being tested at this time by the Kern County Potato Growers' Association, Bakersfield, California. With the completion of a greenhouse 100x20 feet by next harvest season the Washington State Department of Agriculture will be able to make early tests for the growers, enabling them to have the disease readings at the time seed potatoes are marketed.—HAROLD S. SCHAAD.

PROGRAM

POTATO ASSOCIATION OF AMERICA

ROOSEVELT ROOM—HOTEL MORRISON

CHICAGO, ILLINOIS

In Cooperation with the International Crop Improvement Association

President, E. B. Tussing, *University of Ohio, Columbus, Ohio*

Secretary, W. H. Martin, *Rutgers University, New Brunswick, N J*

Monday, Dec. 2, 1946—10 A. M.

1. *Leafroll — Other Virus Diseases* - Discussion Leader — M. W Felton, Nebraska.

   Is aphid the only vector of leafroll?

2. *U. S. Standards for Potatoes* — Discussion Leader — Kris P Bemis, Washington, D C.

   What changes, if any, should be made in these standards to make them more satisfactory to industry? How about maturity, size, dirt?

3. *Potato Nematodes — Fertilization — Special Problems* — Discussion Leader— R J. Haskell, Washington, D C

   The Potato Nematode in Idaho and Prince Edward Island — Gerald Thorne, A D Baker, W. N Keenan

   Nutrition Deficiency Symptoms in Potatoes — (Slides) — K. C. Berger.

   Stem Streak Necrosis of Potatoes in Relation to Intense Soil Activity — K. C. Berger

4. Appointment of Committees.

Tuesday, Dec. 3, 1946—9 A. M.

1. Report of Secretary-Treasurer, Editor.

2. Report of Committees.

3. *Late Blight* — Discussion Leader — H. M. DARLING, Wisconsin.

   New Control Materials. Should we have certification tolerances?

   The Use of Copper Sulphate in Irrigation Water for the Control of Late Blight — C. W. FRUTCHEY.

4. *Ring Rot* — Discussion Leader — G. H. STARR, Wyoming.

   Progress Reports in Seed Certification — What are the best disinfectants for machinery and storage houses?

   Steam Sterilization to Kill Corynebacterium sepedonicum on Burlap Bags— G. H. STARR

   The Control of Ring-rot in South Dakota — JOHN NOONAN.

   The Longevity of Corynebacterium sepedonicum on Potato Bags When Placed under Various Environmental Conditions — G. H. STARR.

   The Effect of Different Concentrations of Bacterial Suspensions Used in Inoculation upon Subsequent Ring-Rot Symptoms in the Potato Plant— G. H. STARR.

   Field Testing of Disinfectants for the Control of Potato Ring-Rot Bacteria on Wooden, Metal, and Cut-seed Surfaces — (Slides) — L. CARL KNORR

5. *Insecticides and Fungicides* — Discussion Leader — A. A. GRANOVSKY, Minnesota.

   Progress Report on DDT, Other New Materials Methods of application, ground *vs.* airplane application.

   Results of Spraying and Dusting Potatoes in Michigan in 1946 — J. H. MUNCIE and W. F. MOROFSKY.

   The Use of New Insecticides in Control of Potato Insects — W. F. MOROFSKY and J. H. MUNCIE.

   Potato Insect Control in Colorado — GEORGE M. LIST.

   Insecticidal and Fungicidal Dusts from the Standpoint of the Manufacturer and Processor — JAMES McCONNON.

Wednesday, Dec. 4, 1946—9 A. M.

1. *Economic Research* — Discussion Leader — E. L. NEWDICK, Maine.
   Storage and Handling Problems in Maine — E. L. NEWDICK
   By-Products and Potato Packages — KRIS P. BEMIS

2. *Breeding and New Varieties* — Discussion Leader — A. G. TOLAAS, Minnesota
   Recent Developments in Potato Breeding — F. A. KRANTZ
   Procedures in Introduction of New Varieties — H. C. MOORE
   Problems Related to Introduction and Testing — H. O. WERNER.
   Potato Breeding in North Dakota — HAROLD MATTSON.

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COMPARISON OF DIFFERENT ORGANIC AND COPPER FUNGICIDES AND SOME COMBINATIONS OF FUNGICIDES WITH DDT FOR THE CONTROL OF POTATO DISEASES AND INSECTS

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AND

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Bordeaux mixture has long been the standard spray material for potatoes in Maine. The potato farmers, however, are interested in having better fungicides. Such fungicides must be relatively cheap to use and easy to prepare and apply, and must give good control of early and late blight. They also should be compatible with the insecticides that may be necessary for the control of the different insects that commonly infest the potato.

It would be of benefit also to have a spray material for Maine conditions that does not coat the leaves with a heavy spray residue that will mask the symptoms of the virus diseases and thus hinder roguing in seed growing operations Furthermore, the spray material should not retard the maturity of the plants and thereby delay the date of harvest of the crop. The writers in 1945 compared a number of different copper and organic fungicides, as well as some combinations of different fungicides with DDT (abbreviation for dichloro-diphenyl-trichloro-

[1]Plant Pathologist.

[2]Field Assistant for Sherwin-Williams Co, and Assistant, Department of Entomology, Ohio State University.

ethane) regarding their ability to control the diseases and insects The results of these experiments are summarized in this paper

Comparison of Different Copper and Organic Fungicides

Four other copper fungicides and three organic materials possessing fungicidal properties were compared with Bordeaux regarding their effect on the yield rate and the control of late blight, early blight, and flea beetle injury. Table 1 gives a summary of the data secured from this experiment.[3]

The plots sprayed with Bordeaux mixture were the greenest and best in general appearance toward the end of the season with the least amount of early and late blight infection and with very little flea beetle injury. Despite this fact, the yield rate was somewhat less than for the other copper fungicides. Bordeaux mixture delayed the maturity of the plants and had a depressing effect on the yield rate, a condition previously reported as sometimes occurring in Maine (2, pp. 186-187 and 3, p 347). However, in normal seasons when early killing frosts do not occur, this delayed maturity is generally associated with increased yields. It also should be noted from the data in table 1 that Basic Copper Arsenate gave the best control of flea beetle injury but was inferior to Bordeaux for the control of early and late blight.

It may be noted from the data in table 1 that the three organic materials used here were inferior spray materials and gave low yield rates in comparison with the copper fungicides. Isothan Q 15 possessed very little fungicidal and insecticidal value. Phygon (U. S Robber No. 604), previously reported by Heuberger and Manns (6, p 109) and by Ruehle (9) as being a promising spray material for potatoes, gave excellent control of late blight in these experiments. It was superior to Bordeaux for the control of late blight but failed to control flea beetle injury and early blight The writers did not observe that Phygon injured the foliage as reported by Ruehle (9, p 244) and they feel that the low yield for this material as reported in table 1 was caused, to a large extent, by its inability to control the insects.

Effect of Applying DDT in Combination with Copper and Organic Fungicides

Effect of DDT on Yield Rate.—An experiment was also conducted in which DDT was combined with three copper and three organic

[3]The fungicides were applied with a motor driven power sprayer maintaining 300 pounds pressure and mounted on a truck, and equipped with a hose long enough to reach the different plots. Each plot was four rows wide and 25 feet long. Yields and disease and insect control data were taken from the two center rows of each plot Seven applications of spray were made during the season.

TABLE I—*The effect on yield rate, early and late blight infection and flea beetle injury from spraying Katahdin potatoes with different copper and organic spray materials*

Fungicide	Formula	Yield per Acre[1]		Protective coefficient[2]		
				Late Blight	Early Blight	Flea Beetles
		Barrels	Bushels	Per cent	Per cent	Per cent
Bordeaux (control)	8-6-100	129	355	100	100	100
Cuprocide[3]	2-100	137	377	89	72	77
Copper Compound A[4]	4-100	132	363	90	81	74
Tribasic copper sulphate[5]	4-100	132	363	99	88	68
Basic copper arsenate[6]	4-100	131	360	89	80	103
Isothan Q15 (lauryl isoquinolinium bromide)[7]	1 pint in 100 gallons	114	314	43	35	60
Phygon (2-3 dichloronaphthoquinone-1-4)[8]	1-100	109	300	102	78	60
Puratized (phenyl mercuri triethanol ammonium lactate)[9]	0 8-100	108	297	90	97	60
Check (unsprayed except for control of Colorado potato beetles)	—	110	303	10	24	20

[1]Average of six replicated two-row plots each 25 feet long Significance at 1 per cent level is 11 95 barrels or 30 39 bushels, at 5 per cent level 9 04 barrels or 24.86 bushels

[2]Equal to infective index of Bordeaux plots (which is 100) divided by infective index of treatment compared (Adapted from Horsfall, James G., and John W. Heuberger Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32: 226-232 1942.)

[3]Yellow copper oxide containing 83 per cent metallic copper and supplied by Rohm and Haas, Philadelphia, Pa

[4]Tetra copper calcium oxychloride supplied by E I Du Pont de Nemours and Co, Wilmington, Del

[5]Supplied by Tennessee Copper Co., Copper Hill, Tenn., and containing 52 per cent metallic copper.

[6]Supplied by Sherwin-Williams Co, and containing 41 per cent metallic copper and 37 per cent arsenic oxide

[7]Supplied by Onyx Oil and Chemical Co, Jersey City, N. J.

[8]Supplied by Naugatuck Chemical Division of U. S. Rubber Co, Naugatuck, Conn

[9]Supplied by Puratized, Inc., New York, N Y

copper-free spray fungicides The fungicides included with and without DDT in this test were Bordeaux mixture, Basic Copper Sulfate, Basic Copper Arsenate, Fermate, Karbam Z, and Dithane The yield data derived from this experiment are summarized in table 2

The plots sprayed with Bordeaux mixture (without DDT) yielded slightly less than those that received the other copper fungicides These data confirm those presented in table 1 that Bordeaux may have a depressing effect on the yield rate.

The plots sprayed with Fermate, a copper-free fungicide, produced the lowest yield rate in the experiment Heuberger and Manns (6, p 109) reported that Fermate has little value for the control of early blight of potatoes. Sleesman *et al.* (10, p. 249) also secured low potato yields when Fermate was used as a spray fungicide They obtained better yields when it was used as a dust. In contrast Karbam Z, another copper-free organic spray material, was one of the better fungicides and produced the highest yield rate. Dithane, also an organic copper-free spray material, likewise was a good fungicide

It may be noted from the data in table 2 that the addition of DDT to the spray fungicide increased the yield rate from 55 to 115 bushels per acre or from 16.3 to 32 1 per cent. DDT appeared to be especially effective in increasing the yield rate when applied with the neutral copper and certain organic fungicides

These data support those of other workers that applications of DDT may greatly increase the yield of potatoes. Bronson, working in Maine in 1944, increased the yield rate over the controls from 48 to 78 per cent by the addition of DDT to certain dust fungicides (8, p. 524-525 and table 36, p. 584). Sleesman *et al*, (10, p. 248) working in Ohio found that DDT used alone, or in combination with various fungicides, gave remarkable control of the potato insects and significantly higher yields. Likewise, DDT gave significant yield increases in experiments conducted in Connecticut, New Jersey, New York, Ohio and Pennsylvania (11) and Granovsky (4) in Minnesota reported striking control of flea beetles and very promising results for the control of some of the other potato feeding insects.

Effect on Control of Early and Late Blight.—The question arose as to whether the addition of DDT to the spray material would decrease its value for the control of the diseases and insects Table 3 summarizes the data pertaining to the control of early and late blight as well as the injury caused by the flea beetles and aphids

DDT, when applied to the potato plants in the absence of a fungicide, appeared to possess no fungicidal property for the control of early

TABLE 2—*The effect on yield of spraying Katahdin potatoes with different fungicides and with combinations of these fungicides with DDT*

Fungicide	Formula	Yield per Acre[1]		Increase from Applying DDT	
		Without DDT	With DDT[2]		
		Bushels[3]	Bushels[3]	Bushels[3]	Per cent
Bordeaux control	8-6-100	355	413	58	16.3
Basic copper sulphate	4-100	358	473	115	32.1
Basic copper arsenate	4-100	363	451	88	24.2
Fermate (ferric dimethyldithio-carbamate)	2-100	316	371	55	17.4
Karbam Z (zinc-dimethyldithio-carbamate)	2-100	363	426	63	17.3
Karbam Z and soap	2-1-100	347	410	63	18.1
Dithane (disodium ethylene bis-dithiocarbamate)	2 qts—1 lb. $ZnSO_4$ and ½ lb. lime	352			
DDT (dichloro-diphenyltrichloro-ethane)	2-100	—	443	91	25.8
Unsprayed control		303	341	38[4]	12.5[4]

[1]Average of nine replicated two-row plots each 25 feet in length for each treatment.
[2]Two pounds 50 per cent DDT (1 pound of actual DDT) added to 100 gallons of spray material
[3]Significance at 1 per cent level is 32.9 bushels, at 5 per cent level 24.9 bushels.
[4]Increase above that of unsprayed control.

TABLE 3—*Comparison on the control of early blight, late blight, flea beetles and aphids from spraying Katahdins with different fungicides and with combinations of these fungicides with DDT.*[1]

Fungicide	Protective Coefficient[2]							
	Early Blight		Late Blight		Flea Beetles		Aphids	
	Without DDT	With DDT	Without DDT	With DDT	Without DDT	With DDT	Without DDT	With DDT
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Bordeaux control	100	120	100	108	100	142	100	157
Basic copper sulphate	89	96	100	107	96	161	131	171
Basic copper arsenate	89	83	98	101	103	149	77	174
Fermate	92	107	75	70	80	124	101	157
Karbam Z	115	111	87	84	90	127	114	164
Karbam Z and soap	119	122	86	88	92	134	111	173
Dithane	97	104	99	105	65	132	101	162
DDT, no fungicide	—	22	—	4	—	92	—	146
Unsprayed control	24	—	10	—	20	—	77	—

[1]Using data secured from same plats that supplied the data for table 1

[2]Equal to the infective index for Bordeaux (which is 100) divided by the infective index of the treatment compared (Adapted from Horsfall, James G. and John W. Heuberger. Measuring magnitude of a defoliation disease of tomatoes Phytopath 32: 226-232 1942.)

and late blight. Also Horsfall and his co-workers (7, p. 150) found that this material possessed no fungicidal properties with respect to *Macrosporium* and *Sclerotinia*. However, when DDT was combined with certain fungicides included in the experiments here reported, the control of these diseases was greatly increased as is shown by the corresponding increase in the Protective Coefficients in table 3.

It may be observed from the data that the Protective Coefficient for early blight was increased by the addition of DDT for Bordeaux Mixture, Basic Copper Sulphate, Fermate, Karbam Z (with soap) and Dithane. Heuberger (5) showed that the amount of early blight infection on tomatoes was reduced by spraying the plants with a fungicide containing derris. According to him controlling flea beetles improved early blight control in two ways: 1, by reducing the number of wounds or punctures which serve as infection courts, and 2, by reducing the dissemination of the Alternaria spores.

It will be shown later in this paper that applications of DDT greatly reduced the number of punctures caused by flea beetles and it is possible that this was a factor in reducing the amount of early blight. However, the development of early blight in potatoes is greatly influenced by the physiological age of the plant. Applications of DDT were found to delay the maturity of the plants in the experiments and this delay in maturity was associated with correspondingly less early blight. The data in table 3 also show that the protective value of DDT for the control of flea beetles is increased by being combined with a fungicide. Likewise, it may be observed from the data in table 3 that DDT increased the control of late blight for the following fungicides, namely, Bordeaux mixture, Basic Copper Sulphate, Basic Copper Arsenate, Karbam Z (with soap) and Dithane. It is not known whether the control of flea beetles and aphids by the application of DDT had an influence on the relative control of late blight by these materials.

It is of interest here that Granovsky (4, p. 499) found that DDT has a considerable fungicidal value for the control of late blight when applied as a 5 per cent dust. The writers, as previously stated, noted that DDT possessed no fungicidal value for the control of late blight when applied in the absence of a fungicide at the rate of 1 pound in 100 gallons.

Control of Flea Beetle and Aphid Injury.—Much of the yield increase derived from the use of DDT in the spray fungicide as reported in table 1 was the result of reducing the injury caused by flea beetles and aphids.

It may be noted from the data in table 3 that in the absence of DDT

certain fungicides were less effective in repelling flea beetles than were others. Fermate, Karbam Z, Karbam Z and soap, and Dithane were less effective in reducing the injury caused by flea beetles than were Bordeaux Mixture, Basic Copper Sulphate, and Basic Copper Arsenate. Dithane, especially, was a poor repellent of flea beetles and the Protective Coefficient was only 65.

The addition of DDT greatly increased the control of flea beetles for all of the fungicides and the value of the Protective Coefficient, in all cases, was significantly higher than for the fungicides that did not contain this insecticide

It is of special interest that DDT, when applied to the potato plants in the absence of a fungicide, had a coefficient of 92 for the control of flea beetles and that when a fungicide was included the Protective Coefficient for flea beetle control was increased from 124 for Fermate to 161 for Basic Copper Sulphate. It would thus appear that the fungicides appeared to have an effect of synergism when in combination with DDT and increased the effectiveness for the control of flea beetle injury

The control of aphids is also an important factor that influences the yield rate of potatoes in Maine The Katahdin variety, used in these experiments, is very susceptible to aphid injury as was shown by Adams (1). Aphids, when present in large numbers, cause the foliage of this variety to become badly distorted or curled and early dying may result with a corresponding reduction in the yield rate.

Observations made in previously conducted experiments had indicated that the aphid population often is greater in fields sprayed with Bordeaux than in those that received applications of the neutral copper fungicide. The data in table 3 confirm the contention that the different fungicides may influence the aphid population in the absence of DDT or other insecticide. The plots sprayed with Bordeaux harbored significantly more aphids than those that were sprayed with Basic Copper Sulphate, Karbam Z, Karbam Z and soap, and Dithane as is indicated by the larger Protective Coefficient (The plots that were unsprayed or were sprayed with Fermate harbored more aphids than did the plots that were sprayed with Bordeaux mixture) The data presented in table 3 show that the aphid population was significantly reduced in all cases where DDT was applied The insecticide did not afford perfect control of aphids, but did reduce their numbers sufficiently to prevent the leaf injury previously mentioned The records showed that DDT destroyed approximately 80 per cent of the aphid population. However, the remaining 20 per cent of the aphids probably were sufficient to be a decided factor in the dissemination of leafroll and other virus dis-

cases, especially in view of the fact that the plants that received DDT remained green for approximately two weeks longer than those that did not receive the insecticide.

Discussion

Bordeaux mixture has for a long time been considered one of the best fungicides for the control of the potato diseases. It has given good control of early and late blight and is a fairly effective repellent for flea beetles and leafhoppers. Some farmers, however, feel that Bordeaux is rather bothersome to prepare and apply. It also may delay the maturity of the plants and thus postpone the harvesting date.

The neutral copper fungicides are easier to prepare than Bordeaux, but have the disadvantages of being somewhat less effective fungicides and lacking in the ability of repelling flea beetles. The addition of DDT to the neutral copper fungicides seems to remedy these disadvantages and it is quite possible that such a spray combination may replace Bordeaux mixture to a large extent.

There is a great deal of interest in the development of new organic fungicides that will be suitable for spraying potatoes. Some of these appear to have merit for the control of the blight diseases, but have the serious defect of giving little or no control for the injury caused by flea beetles and the other potato insects. When DDT was added to certain of these organic spray materials, the diseases and insects were controlled and good yields were obtained. It may be expected that good organic fungicides will be developed for potato spraying provided DDT or another material is used to control the insects.

DDT gave excellent control of flea beetles and greatly reduced the number of aphids when in combination with a fungicide. In the absence of a fungicide DDT increased the yield 38 bushels per acre or 12.5 per cent above the unsprayed controls. This increase may justly be attributed to the reduction in the number of flea beetles, aphids, and other insects.

The farmers of Maine are hopeful that DDT will reduce the aphid population sufficiently to control the spread of leafroll. DDT, when applied at the rate of one pound per 100 gallons of spray mixture, reduced the aphid population approximately 80 per cent which was sufficient to prevent excessive injury to the potato plants and thus increase the yield rate. However, it is probable that enough aphids survived to widely disseminate leafroll and other virus diseases. Studies must be conducted to discover methods whereby the aphid population can be reduced to a greater extent. The use of DDT by more farmers, higher concentra-

tions or more frequent applications of DDT, better equipment for applying the insecticide, and the wider use of such cultural practices as weed control and early planting and harvesting of the crop will help to solve the problem.

It is significant that the addition of DDT to the fungicide spray materials appeared to increase their fungicidal value for the control of both early and late blight. Furthermore, when this insecticide was combined with certain fungicides, the control of flea beetle injury was increased significantly above that secured when DDT was used alone. DDT in these experiments gave approximately an 80 per cent control of aphids which was sufficient to greatly reduce the injury caused by these insects and greatly affect the yield rate.

In view of these results, and those secured by other workers, it appears that DDT may change considerably the practice of spraying potatoes Bordeaux mixture may be replaced by the neutral coppers or certain organic fungicides in combination with DDT or other insecticides.

Summary

There is a need for a material that can effectively replace Bordeaux mixture as a spray material for potatoes.

Bordeaux mixture depressed the yield rate despite the fact that it gave good control of flea beetles and the blight diseases.

Phygon, Karbam Z, and Dithane appear to be promising organic fungicides for potatoes but lack the ability to control flea beetle injury.

DDT, when used with different fungicides, increased the yield rate from 55 to 115 bushels per acre or from 16.3 to 32.1 per cent.

Certain shortcomings of the neutral copper and organic fungicides are greatly offset when applied with DDT. A neutral copper or organic fungicide may replace Bordeaux if used in combination with DDT or similar insecticides.

The protective value of some spray fungicides for the control of early and late blight has increased when used in combination with DDT Also the protective value of DDT for the control of flea beetles likewise was increased by being combined with a fungicide.

DDT reduced the aphid population about 80 per cent which was sufficient to prevent the excessive injury and thus the yield was increased

The different fungicides in the absence of DDT differed regarding the relative aphid population that developed on the sprayed plants.

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EFFECT OF ALKALI SALTS ON SHAPE AND APPEARANCE OF RUSSET BURBANK POTATOES[1]

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The Russet Burbank potato tuber as grown in Idaho is typically of elongated, cylindrical shape with blunt ends, shallow eyes, and a very prominent uniform russeting or netting of the outer skin (Fig 1A). Both the shape and the skin characteristics are of great importance and the loss of one or both factors seriously reduces the appearance and sale value of the tubers. This paper presents information which explains the occasional occurrence of smooth and sometimes round Russet Burbank tubers.

While making surveys in 1943 for potato storage diseases conducted by the Emergency Plant Disease Prevention Project, U. S De-

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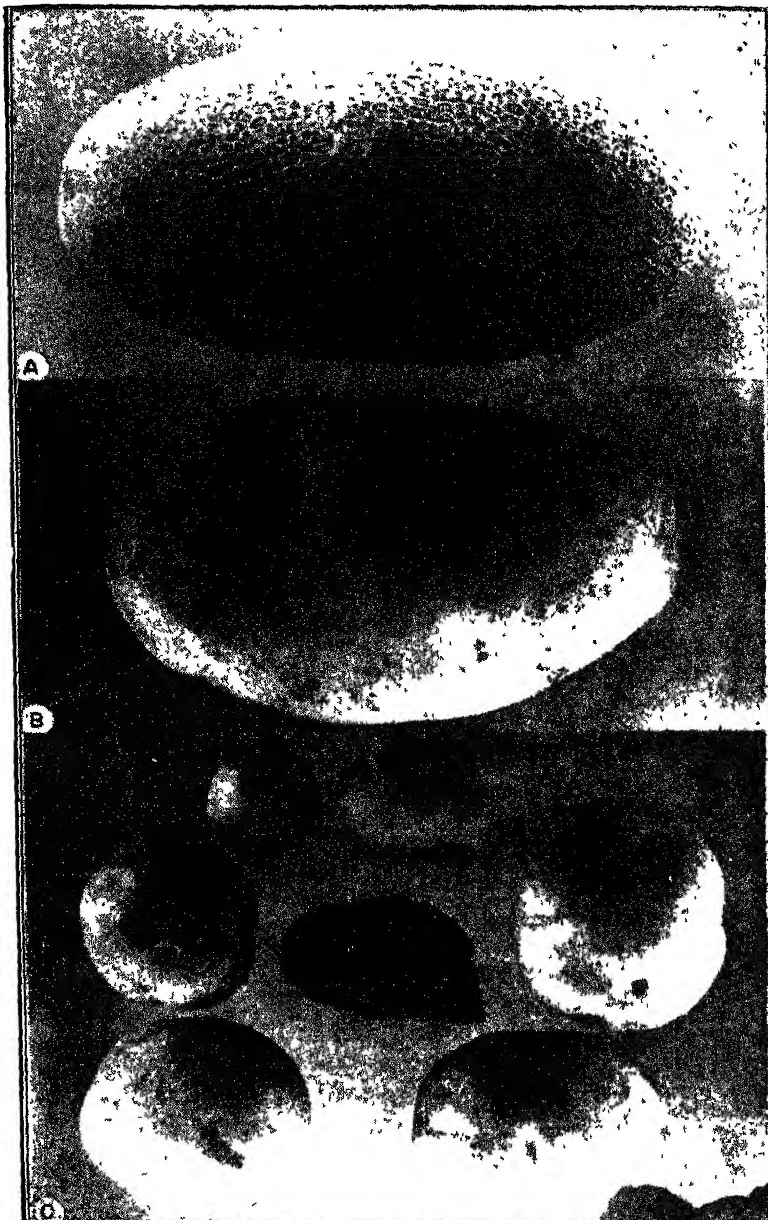

FIGURE 1.—The effect of soluble salts on tuber shape and appearance of Russet Burbank potato A. Tuber showing typical shape and uniform netting B. Tuber grown on edge of alkali spot where excess salts materially changed netting and also altered shape C Tubers grown in alkali soil These potatoes all from one hill are perfectly smooth skinned, small, and shaped like Rurals In the center is the original whole seed tuber still attached to the plant when dug showing netted skin and elongated shape.

partment of Agriculture, the senior writer accompanied by Mr. E. W. Whitman, Extension Potato Specialist, University of Idaho, found that certain lots of potatoes in certain areas showed a considerable number of smooth-skinned tubers in the Russet Burbank variety. There were wide variations in tuber shape and degree of netting. Information furnished by local dealers indicated that this condition was due to the effect of alkali soil, and was particularly prevalent on spots that had been scraped in order to level the land for irrigation. Tests by growing some of these potatoes on ordinary soil in 1944 showed that there were at least two factors involved since some of the smooth tubers when used for seed produced smooth tubers, whereas others produced tubers of normal shape and netting. It has been demonstrated at the Aberdeen Branch Station that excess nitrogen (commercial fertilization as well as natural) will tend to produce smooth skinned tubers from Russet stock. Experience has shown too that certain sports or mutations occur in which the plants are normal but tubers are smooth skinned; an apparent reversion to the original Burbank potato.

In 1944, while examining potatoes during harvest in a field near Aberdeen, Idaho, the writer noticed that in the lower end of the field vine growth had been poor and the crop was not being dug. This area had been scraped (in order to level the land for irrigation) and generally over the surface there was a heavy accumulation of white alkali salts. It was found that the tubers produced in this portion of the field were smooth skinned and shaped like Idaho Rurals (Chas. Downing) (Fig. 1,c). The seed pieces, however, in many cases still well preserved, were small, whole tubers showing the typical shape and netting of the Russet Burbank variety. (Fig. 1.C. center). The tubers became more elongated as the soil conditions became less saline toward the outer edges of the alkali spots. The skin, however, still remained smooth. (Fig. 1 B.) The tubers approached normal netting and shape as soil conditions became less saline. A small patch was noted near the center of the field in which this entire range of netting and tuber shape occurred.

Experimental Results

Two experiments conducted in the greenhouse were designed to study: (1) the behavior of the smooth tubers when used as seed and (2) the effect of naturally and artificially adjusted high salt content of the soils on tuber and skin characteristics.

Test 1. Twenty hills of potatoes were planted on the . .

March, 1945, in a large bed in the greenhouse. The soil was uniform, consisting of compost, sand and Palouse silt loam. The description of the tubers used for seed follows:

Rows	No. of Hills	
1-2	6	Six tubers all smooth and shaped like Rurals representing one hill from the alkali patch in the field at Aberdeen. These tubers are shown in Figure 1c
3-4	6	Six normal tubers of certified Russet Burbank grown at Moscow
5-6	6	Six tubers similar to those in rows 1-2 and from the same patch except from different hills
7	3	Three normal tubers of commercial stock grown at Aberdeen See Figure 1A
8	2	From one normally shaped but smooth skinned tuber grown in the same patch as those in rows 1-2 and 5-6 This tuber is shown in Figure 1B

The plantings were watered and cultivated at favorable intervals The tubers were dug and examined on the 19th of July by Dr. Lief Verner, Head of the Department of Horticulture, University of Idaho, assisted by the writers. All tubers produced from the above seed stocks showed typical characteristics of the variety

Test 2. The soils were selected from those areas in which the abnormal tuber characteristics occurred on the farm near Aberdeen Sample No. 1 was from a grain patch, and sample No 3 from a potato patch Both of these soils were considered "good" soils. Sample No 9 was from a potato patch which had produced smooth potatoes and was apparently high in salt content Sample No. 7 was from a low spot in the grain where nothing was growing except weeds and was included to show the high salinity attained by this soil in low areas. Their analyses are as follows

TABLE 1 —*Salinity of Soils*

				Soluble Constituents					
Soil No.	Description	pH	$CaCO_3$ Per cent	Total Solids PPM.	CO_3 PPM.	HCO_3 PPM	Cl PPM.	SO_4 PPM	Na PPM
1	Grain patch	8 2	3 07	1,800	18	512	132	648	130
3	Potato patch	8 4	2 13	1,270	0	549	53	228	68
9	Potato patch	8 2	3 88	8,170	0	488	334	4303	1027
7	Weed patch	8.2	0 35	17 540	0	549	3370	6733	3391

Six, 14-quart galvanized pails were filled with the appropriate soil according to the plan in table 2. Soluble salts of sodium chloride

and sodium sulfate were added to the "good" soils (1 and 3) in sufficient amount to equal the soluble salt content of these salts in No. 9 The lime content was not adjusted because it was nearly similar in all 3 soils The whole tubers of certified seed stock, one to each pail, were planted March 16, 1945. The pails were watered alternately from the surface and from the bottom by standing the pails in shallow water in pans Dr Lief Verner harvested the potatoes in September and rated the skin characteristics as shown in table 2.

TABLE 2.—*Effect of saline salts upon shape and characteristics of Russet Burbank potatoes.*

Sample No	Description	Treatment	Results: No of Tubers	Results: Skin Characters
1	From grain patch 0-6"	Check	3	1—50 per cent well netted 2—slight netting only
1	From grain patch 0-6"	Salts added to equal No. 9 (a)	2 1 second growth	all smooth
3	From potato patch "good" soil 0-10"	Check	7	2—fairly well netted 1—slightly netted 1—smooth with faint trace of netting 3—rough tubers with enlarged lenticels so condition not certain
3	From potato patch "good" soil 0-10"	Salts added to equal No 9	4	3—smooth 1—trace netting
9	From potato patch alkali soil 0-8"	Check	3	all smooth
9	From potato patch alkali soil 0-8"	Check	2	1—smooth 1—very slightly netted on portion of one side (20 per cent of whole surface area)

(a) Based on the analysis of soluble salts in sample No 9 The soil in samples 1 and 3 was adjusted by the addition of calculated amounts of the various salts to equal the condition in soil sample No 9

Discussion

It is evident from the results obtained in test 1 that Russet Burbank potatoes, smooth and shaped like Rurals, will transmit the original varietal characteristics when grown in normal soil free from a high soluble salt content. When good soils, similar in other characteristics to soils of high saline content, were treated with equivalent amounts of soluble saline salts, they produced off-type Russets, round in shape and without netting, as shown in table 2 and illustrated in figure 1

A study of the soils on this farm has indicated that, although the surface soil may seem to be level, there is considerable difference in the depth of the sub-soil. Soil waters accumulate in these low sub-soil areas and, since they cannot escape except by evaporation or slow percolation, cause a high accumulation of saline salts. The effect is at once apparent upon the potato shape and characteristics.

Further study should be made to determine just what is the physiological effect upon the potato but at least it can be said that the addition of high amounts of soluble salts of sodium chloride and sodium sulfate do affect the appearance and shape of the Russet Burbank potato.

Summary

1 Off-type Russet Burkank potatoes, smooth-skinned and shaped like Rurals, transmitted the original varietal characteristics when grown in a normal soil.
2. Russet Burbank potatoes of certified seed stock, when grown in soils of high saline content, produced off-type potatoes with smooth skins.
3. Soils from the same locality, upon which good potatoes were growing, produced similar off-type potatoes when treated with equivalent amounts of sodium sulfate and chloride salts.

SECTIONAL NOTES

CONNECTICUT

As suggested on the 2d of October, a very large per acre and state yield of potatoes resulted in Connecticut Many credit D D.T. with being largely responsible for the big crop, but consideration should be given also to the ample rainfall from the 20th of July to the end of the growing season.

The yields from the cooperative fertilizer trials on farms are now available and a brief summary follows In all cases 2000 pounds of 5-8-7 or 5-10-10 fertilizer were applied in bands with the planter.

Broadcasting and disking in, before planting, of 1000 pounds per acre of castor pomace (containing about 50 pounds of nitrogen) increased the total yields from 40 to 100 bushels per acre. The average increase from three farms was 70 bushels. Practically the same results occurred where 1000 or 2000 pounds of the pomace were applied

On one farm, sulfate of ammonia, at 500 pounds per acre, was also tested as the source of extra nitrogen. It kept the vines alive longer and produced larger yields than castor pomace at either 1000 or 2000 pounds.

The preceding results were obtained on farms where potatoes are grown under an almost continuous culture system. Under such conditions, it is quite probable that more nitrogen and less phosphoric acid than is carried by a ton of 5-8-7 or 5-10-10 fertilizers should be applied to potatoes. The 1946 and previous results indicate that about 150 pounds of nitrogen, 100 pounds of phosphoric acid and 150 to 200 pounds of potash should be carried by the fertilizer for non-rotated potatoes. This is a radical change from a 1-2-2 to a 3-2-3 or 3-2-4 ratio. Until more data are obtained, it is suggested that 50 to 60 pounds per acre of extra nitrogen be added in early spring to the rye cover crop or disked in before planting the potatoes as a supplement for a ton of 5-8-7 or 5-10-10. (Dec 5).—B. A Brown.

IDAHO

Certified seed potato acreage passing the final field inspection in Idaho in 1946 is as follows:

Netted Gems	9,223.45
White Rose	135.00
Bliss Triumph	114.50
Chippewa	30.25
Idaho Rural	4 50
Katahdin	3.00
Total	9,510.70

Harvesting was difficult because of poor weather conditions and labor shortage An estimated 5 per cent of the seed potato acreage is still in the ground and some that were harvested had field frost damage Frost only damaged the commercial crop to some extent and it is esti-

mated that approximately 10 per cent of the commercial potato acreage in the Twin Falls area was frozen in the ground. Yields on irrigated potatoes were above last year but dry farm fields yielded approximately half of what they did a year ago. The total production of certified seed is slightly under last year with a large amount of over-sized tubers in the irrigated lots. These over-sized tubers will be shipped as commercials and their removal will result in the supply of certified seed being considerably lower than in 1945. Our White Rose seed is practically sold but there has been little movement in the other varieties to date

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District meetings of the seed potato growers have been held throughout Idaho in order to discuss seed potato problems and elect members to the Potato Advisory Committee of the Idaho Crop Improvement Association The potato committee elected were: Fred Brady, Ashton; Arthur Bowles, Driggs, Harold Smith, Darlington; Herman Heinrich, Lakefork, Lyle Billow, Nezperce; George Strecker, Sandpoint.

This committee will meet in Boise on the 19th and 20th of December to revise certified seed potato regulations.

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Four hundred and thirty-five winter test plot samples have been prepared and shipped to California where they will be planted on the 4th of December (Dec. 3).—JOHN R ROBERTSON

INDIANA

The food production program in Indiana for 1947 will follow closely that of the nation, except for potatoes. Our growers are being asked to increase the total production by at least 6 per cent and possibly 10 per cent or more. If this increase materializes, we will still be considerably short of our requirements and will depend on the surplus potato areas to continue to keep us supplied. Our commercial growers are not up to full production and it is doubtful if we will find new growers willing to risk potatoes under this unsettled potato program Indiana will continue to be a good market for good table stock and certified seed.

Under the "5 Star" program of the State of Maine, more Maine potatoes are being purchased in Indiana than ever before. Those growers are to be congratulated on their packaging and grading, for after all the packaging and grading is what will sell potatoes (Nov 26) —W B WARD.

MAINE

The price support program is the only bright spot in the potato deal in Maine With the largest crop in history of approximately 76 million bushels, Maine is faced with a tremendous task of moving the crop. Prices have been below support during the entire fall Approximately 2300 special loans were made by Commodity Credit and about 3050 regular loans have been made. The special loans are on potatoes in temporary storage in barns, sheds, garages and in piles in potato fields Approximately ½ million bushels were stored in piles covered with straw, boughs and dirt These have, in all probability, frozen to the point that there will be no salvage value on them. From 8 to 10 million bushels were stored in temporary storage, some of these moved into regular channels of trade and to starch factories and alcohol plants, but the severe freeze the last of November has resulted in these potatoes freezing, so they will not find their way into regular channels of trade. Commodity Credit is having its inspectors examine the special loan potatoes and they are being dyed. The special loans were non-recourse loans.

Already farmers are offering 20 per cent of their crop in many cases It is hoped that Commodity Credit will be able to dispose of this 20 per cent during the month of December, otherwise, it may exert a bad influence on the market and on those having loans

The potato crop is excellent. There was very little late blight and the average yield of 355 bushels is the highest on record for Maine. This is due, in large part, to the use of DDT.

Several potato combines or harvesters were tried in the country this year. Some of them show promise but all of them need some improvement before they will be accepted generally by the county. (Dec. 5) —Verne C. Beverly.

MICHIGAN

The shipment of table stock from Michigan was below that of last season Our rail shipments are 600-car and truck shipments equivalent to car run over the 1000-car mark with a total of more than 1600 cars short of last year's shipments to date. With a larger crop to move, this means only one thing—that we have a lot of shipments to make during the balance of the season, by one way or another.

Temporary storage lots are cleaning up, but very little stock in permanent storage has been shipped Our estimate would be that

50 per cent of the storage stock is under loan, because growers are sitting tight and waiting for government's move

Our certified seed crop is about equal to that of last year with a slight increase in Russet Rurals. Interest and inquiry for seed are normal with very little shipped out at this writing. However, Michigan seed shipments are usually late—most shipments being made during February, March and April. (Dec 6) —H. A Reiley

NEBRASKA

The final or bin inspection on Nebraska Certified potatoes is practically completed at this time It has been a long job for a full crew of inspectors. This was necessary because of the large volume to be inspected, and the quality of the crop this year Frost came late throughout the western part of the state, even being delayed until the 8th of October in one area. With harvest being held up, and with ample moisture throughout the fall, very heavy yields resulted However, those same conditions made harvesting very difficult Considerable cracking and bruising resulted. As a result, Nebraska is now faced with the greatest tonnage of certified potatoes it has ever had, but with approximately an average years' No 1 yield.

At this time considerable interest is being expressed on the part of growers relative to the government control of acreage next year It is the general feeling that something should be done soon in establishing something definite Growers are unable to determine their seed needs for next year under the present information In any event, Nebraska is almost sure to have a reduction in acreage for certification next year, whether it be through government reduction or voluntary.

A large percentage of growers have taken out the government loan on their potatoes. This was done more as a security measure Shipments have been moving out to Southern Texas all this month and will continue until almost Christmas High quality table stock has been moving out in good shape, despite the unsatisfactory market (Dec. 1.) —Joe Shaughnessy.

NEW YORK

Up-state New York, a normal late producing area, finds winter creeping up with potato storages filled to the doors and most temporary storages running over.

Many growers have signed up under both the permanent loan

and the special programs by the government Despite this fact, however, the potato market is generally low because so many odd lots get to market at buyers prices The support program can't work successfully unless a high percentage of growers are signed up

Long Island also goes into the winter with plenty of potatoes They enjoyed their biggest yield on record and although they already have moved more than usual they find themselves overstocked. Markets in general are dull.

Certified seed growers all find themselves in a predicament The high yield has caused too much oversize and many lots will be graded into table stock because of the shrinkage for the seed trade. Growers who killed their vines early and have small size as well as virus disease freedom, and there are quite a few who did this, are getting good demand for their seed at a premium

Growers in general are reconciled to the control of acreage for 1947 and believe the cut should have been higher This attitude prevails in all late producing areas of the state The intermediate areas, which were cut about 23 per cent, are not so well pleased but fortunately know that it had to be done (Dec. 2).—H. J. Evans

OHIO

The potato acreage in Ohio for 1946 was the lowest on record, but the average yield was the highest on record The higher yields per acre were due in part to the general use of DDT and in part to the excellent climatic conditions that existed during the growing season

Ninety per cent of the total crop has been marketed and, on the whole, the prices paid to growers have been lower than last year, but somewhat above the general market prices for shipped-in potatoes

The growers in the state seem to be satisfied with the acreage allotted the state of Ohio which is somewhat larger than was the acreage this year It is generally thought that the acreage will be slightly under that allotted the state or at least will not exceed the allotment.

Although the growers in Ohio have not sold any potatoes to the government they realize the necessity of some type of control program if the government is going to continue to support potatoes at parity prices. (Dec 6) —Earl B Tussing

OREGON

Leafroll was the number one villain in the Oregon seed certification

drama this year, as can be seen from the following report of J R. McCambridge, Seed Certification Specialist

Acres entered, all varieties	5,526
Acres passed field inspections	2,801
Acres rejected	2,725
Per cent of acreage rejected	49 7 per cent

Reason for Rejection	*Per cent of Acres Rejected*
Leafroll	54.7
Rugose mosaic	6.1
Mild mosaic	2.3
Blackleg	5.7
Ring rot	11.3
Wilt	.7
Isolation	4.4
Varietal mixture	.2
Advised growers to withdraw	14.5

In most cases, the withdrawals were also due to leafroll. The puzzling question is, why has leafroll suddenly become so serious? It has always been here in Oregon, but only in the last three years has it spread so alarmingly.

McCambridge and his assistant, Dick Adlard, are now busy at Oceanside, California, planting the test plot which occupies 6½ acres. All samples were previously gassed to break dormancy. Last year, potatoes were halved for the test plot on the theory that two individual plants were easier to diagnose than one This year we have gone back to our original plan of using small whole seed because thereby we can use larger samples and because the whole seed gives much better emergence For acreages of less than 20, we plant 420 "single drop" tubers and use 840 for acreages over 20 In all cases of foundation seed, we use 840 tubers regardless of acreage

The commercial crop has established a record for the state Netted Gems are selling rather readily as this is written for $2 to $2 10 per 100-pound sack plus sacks — that is, the dealer furnishes the sack Sacks this year cost 20 cents so the price is slightly over the support price for November

Many Klamath growers are taking out loans on the theory that they have nothing to lose thereby, except some compliance with red tape inherent in governmental regulations (Dec 1) —E. R Jackman

PENNSYLVANIA

The 1946 Pennsylvania potato crop is of good quality and the acreage yields were exceptionally high. The frosts were late and harvesting was mostly completed while the vines were yet green. This has contributed to a rather serious late blight rot loss in storage, which is much worse than usual Most growers that used a herbicide to kill vines prior to harvesting are experiencing no trouble with late blight rots in storage A few growers that used mild fungicides and a poor spraying schedule, had enough late blight development to experience loss even though vines were dead at harvest. Some rots of the "leak" type have been observed this year where losses were quite high. (Nov 26) —O D. BURKE.

The certified seed potato crop produced in Pennsylvania this year is the highest on record The state produced 368,254 bushels compared with 192,222 bushels in 1945. The varieties certified in their order of importance are Katahdin, Russet, Sebago, Teton, Menominee, Cobbler, Houma, White Rural and Sequoia.

This year the virus diseases were not so serious as they were in 1945, when close to 57 per cent of the acreage entered for inspection was rejected compared with approximately 45 per cent rejected this year A number of the rejections this year were for ring-rot, whereas the rejections in 1945 were largely for leafroll The seed crop this year tends to be somewhat coarse — many of the tubers are over-sized and rough and will not meet the grade requirements for certification. There is a trace of blight rot present in a lot of the seed this year and there are indications that the crop will not come through winter storage as well as might be expected

(From time to time our Pennsylvania correspondent has made mention of the number of deer observed in his home state We recently wrote him suggesting that one of his nature stories was due This year he has exceeded himself—his previous reports referred to deer in the twenties or thirties—now he writes of 100 or more We have no reason to question our correspondent's veracity We do question, however, the statement that the goat baiters were from New Jersey Ed)

"On a recent trip to Potter County we counted exactly fifty deer on a late afternoon drive through the Black Forest On a potato inspection trip in this same county a seed grower was contacted and during the course of the conversation he mentioned about the deer running

his new clover seeding He told us he had two thirty acre fields of new clover seeding and that the deer were so thick that he frequently drove his car through the fields during their feeding period in early evening to drive them out. We volunteered to help him some evening so he invited us out that same night.

This farm is located at the edge of the Black Forest. At 7:30 that night we started through the clover fields in a car As soon as we entered the fields we spotted deer with the lights of the car. We spent probably 1½ hours in the two fields and there wasn't a moment that we didn't have deer within range of our lights The lights confused the deer very much and several times we had to slow down to keep from running over them Several times after the deer started moving we had more deer in the range of the lights than we could count

We estimated that there were more than one hundred deer in the two fields The farmer stated that he had been supporting these deer all summer long One need not stretch his imagination to realize how much 100 deer would eat in a pasture durng a summer and fall period.

This farmer usually has his house full of hunters during the deer hunting season but he is very careful as to who he invites in to hunt He still remembers the Jersey visitors that gave his pet goat an overdose of cigarette butts and chewing tobacco"

If any of this deer story would be of interest to the readers of the Potato Journal you are at liberty to use whatever part you might wish (Dec 1) —K W. LAUER

SOUTH DAKOTA

We suspected we had more ring rot in South Dakota potatoes than we could find in bin and tuber inspections Our new inspector, David Giese, of Moorhead has been able to identify it in the growing plants, thereby eliminating those fields from certification We have only 2940 acres passing all inspection to date, and the inspector is watching all grading very closely We are determined to get rid of it, and have the cooperation of the growers Our growers are obtaining ring-rot-free seed from Northern Minnesota, Wisconsin, and North Dakota

We had 7025 acres entered for certification in 1946, and expect the acreage to be about the same in 1947.

Practically all potatoes in the principal producing section of South Dakota in the northeastern part of the state are now under loan to CCC

The inspection of bins is now being made by the Federal State

inspectors, since the C.C C would not accept delivery in the required time Our growers are at a loss to know when deliveries can be accepted, and very few cars are being loaded to go on the open market Inquiries are being received for certified stock but this will apply only to approximately ⅓ of the production in this area.

About 190,000 bushels of potatoes were purchased by the government in piles in the field, and they have now been released for livestock feed However alternate freezing and thawing have made most of the potatoes worthless

The yield of potatoes in this section was very good with many fields yielding 200 to 300 bushels per acre This is on non-irrigated land with only a few growers using fertilizer

Our potatoes are keeping very well in storage, with inspections showing bins scoring over 90 per cent No. 1 quality

Potato acreage allotments are not worrying South Dakota growers. The acreage has been reduced each year of late, and the goal of 30,200 acres is 2,200 acres more than were harvested in 1946. Officials look for further reduction in the acreage of table stock in 1947 (Dec 6) —JOHN NOONAN

ALASKA

A cold late spring and deeply frozen ground contributed to produce one of the latest planting seasons on record A few growers planted by the 15th of May, but the average for the Matanuska Valley was about the 25th The varieties, Arctic Seedling and White Bliss (Green Mountain types), as usual, comprised the bulk of the crop White Gold and American Wonder were grown by a few farmers The exceptionally warm weather in June and early July in addition to adequate rainfall compensated, to a large extent, for the late start The acreage this year was estimated as 30 — 40 per cent less than last year

With the passing of the moose hunting season and the first flush of the duck season, the farmers of the Valley returned to the serious job of harvesting the potato crop The vines were not killed by frost until the 20th of September, although a light frost on the 14th of August did considerable damage in localized low areas. Our yield was above average, approximately 150 bushels to the acre—and the quality was excellent August and September were exceptionally dry this year although they usually are the months of heaviest rainfall

Soldiers that were stationed at Fort Richardson in Anchorage, were utilized in harvesting the crop A number of potato picking machines

are now in use and they will probably become more popular because of the uncertainties of the labor supply and the shortness of the harvest season.

The bulk of the crop, as in past years, will be marketed by the Matanuska Valley Farmer's Cooperative Association. Our farmers received about $4.50 to $5.00 per hundred for potatoes dug in August. The price has held up fairly well because of a short crop and various maritime strikes which have practically closed shipping to Alaska for the last three months. Local price is generally equal to Seattle quotation plus shipping charges. The civilian and military demands, after a temporary slump, are back to wartime levels. It appears that the local crop, with the exception of potatoes held for seed, will be exhausted by spring.

Heretofore most of the potatoes in the valley have been stored in the large Coop cellar, but there is a steady increase in the number of potato cellars on farms. The Tanana Valley Farmers Cooperative, in Fairbanks, has just completed a large, modern potato storage cellar and produce building.

A certified seed potato program has been established by the newly created Territorial Department of Agriculture. A small acreage will be certified this year, mainly for local use. Some seed will be shipped to West Coast growers for trial. (Dec. 1).—ZOLA M. FINEMAN.